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Investigating Operational Performance Outcomes and Adopting Sustainable Supply Chain Management Practices in The Health Sector (As a Case Study on NUPCO Company)

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Abstract: This study aims to explore the relationship between the adoption of Sustainable Supply Chain Management (SSCM) practices and operational performance outcomes in the healthcare sector in Saudi Arabia, using NUPCO as a case study. A descriptive analytical quantitative approach was adopted, and data were collected through an electronic questionnaire distributed to a sample of 289 employees out of a total population of 1,166. The questionnaire addressed SSCM dimensions (green procurement, green distribution, eco-design, and reverse logistics) and operational performance dimensions (quality, cost, and flexibility). The findings revealed a Agree level of SSCM implementation, with an overall mean of 3.41, indicating a tendency toward agreement, while operational performance was Agree, with a mean of 3.99—flexibility being the highest at 4.07. Regression analysis showed statistically significant positive effects: green procurement influenced quality with a coefficient of 0.435, cost with 0.532, and flexibility with 0.405. Eco-design affected quality, cost, and flexibility with coefficients of 0.317, 0.371, and 0.281, respectively. Green distribution had a positive effect on quality (0.327) and cost (0.374), while reverse logistics had a limited effect, impacting only cost (0.131). The study recommends enhancing the infrastructure for green distribution and reverse logistics and integrating green procurement and eco-design practices into operational strategies to improve performance and align with Saudi Arabia's Vision 2030 sustainability goals.

Keywords: Sustainable Supply Chain, Green Procurement, Operational Performance, Healthcare Logistics, Reverse Logistics, Eco-Design

دراسة نتائج الأداء التشغيلي وتبني ممارسات إدارة سلسلة التوريد المستدامة في القطاع الصحي في المملكة العربية السعودية (دراسة حالة على شركة نوبكو)

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المستخلص: هدفت هذه الدراسة إلى استكشاف العلاقة بين تبني ممارسات إدارة سلسلة الإمداد المستدامة (SSCM) ونتائج الأداء التشغيلي في القطاع الصحي بالمملكة العربية السعودية، وذلك من خلال دراسة حالة على شركة نوبكو. اعتمدت الدراسة على المنهج الوصفي التحليلي الكمي، حيث جُمعت البيانات باستخدام استبانة إلكترونية وزعت على عينة مكونة من (289) موظفًا من أصل مجتمع الدراسة البالغ (1166) موظفًا. تناولت الاستبانة أبعاد SSCM (الشراء الأخضر، التوزيع الأخضر، التصميم البيئي، اللوجستيات العكسية) وأداء العمليات (الجودة، التكلفة، المرونة). أظهرت النتائج أن مستوى تطبيق SSCM كان بدرجة مرتفع بمتوسط كلي بلغ (3.41)، في حين حقق الأداء التشغيلي مستوى مرتفع بمتوسط 3.99، وجاءت المرونة في أعلى مستوياتها بمتوسط (4.07) بمستوى مرتفع، وكشفت نتائج تحليل الانحدار عن تأثيرات إيجابية ذات دلالة إحصائية، حيث أثّر الشراء الأخضر على الجودة بدرجة بلغت (0.435)، وعلى التكلفة بدرجة (0.532)، وعلى المرونة بدرجة 0.405. كما أثّر التصميم البيئي على الجودة بدرجة (0.317)، وعلى التكلفة بدرجة (0.371)، وعلى المرونة بدرجة (0.281)، كذلك أظهر التوزيع الأخضر تأثيرًا على الجودة بدرجة (0.327)، وعلى التكلفة بدرجة (0.374)، بينما اقتصر تأثير اللوجستيات العكسية على بُعد التكلفة فقط بدرجة بلغت (0.131)، توصي الدراسة بتعزيز البنية التحتية لممارسات التوزيع الأخضر واللوجستيات العكسية، وتعميق دمج ممارسات الشراء الأخضر والتصميم البيئي ضمن الاستراتيجية التشغيلية لتحسين الأداء وتحقيق أهداف الاستدامة وفق رؤية المملكة 2030.

الكلمات المفتاحية : سلسلة الإمداد المستدامة، الشراء الأخضر، الأداء التشغيلي، الخدمات اللوجستية الصحية، اللوجستيات العكسية، التصميم البيئي.

1- Background of the Topic.

The Health Sector in the Kingdom of Saudi Arabia enjoys significant government support, placing it at the forefront of sustainable development priorities, as it directly impacts human life. Guided by Vision 2030 and the Health Transformation Program, Saudi Arabia aims to enhance access to high-quality health services while promoting sustainability across the supply chain. One of the key players in this transformation is the National Unified Procurement Company (NUPCO) a Saudi Arabian company. Which it plays a critical role in managing the procurement and logistics of medical supplies. NUPCO has been instrumental in integrating sustainable supply chain management practices, aligning its operations with the principles of green procurement, reverse logistics, and environmental sustainability.

(AlTaweel & Al-Hawary, 2021)Sustainable Supply Chain Management (SSCM) is a developing subject whose significance has increased over the last several years due to the rapidly changing business environment and the global nature of supply chains. Nowadays, the competitive nature has transferred from individual firms to supply chains, and environmental management techniques have followed suit. Organizations that embrace SSCM seek to improve environmental and financial performance, IR, and eco-design or design for environmental practices (Nour et al, 2023).

Supply chain management (SCM) is one of the most important and advanced management techniques for integrating and coordinating suppliers, producers, and related business activities. It seeks to provide clean products and services that promote sustainability to the end consumer. The NUPCO plays a pivotal role in this by acting as a centralized procurement body for the implementing sustainable practices in logistics, procurement, and supply chain processes. Through green procurement and reverse logistics strategies, NUPCO ensures that medical products and services are delivered in a manner that supports the Kingdom's sustainability goals. As an integral part of Vision 2030, NUPCO's sustainable supply chain practices demonstrate how logistics management can serve both operational efficiency and environmental stewardship in the healthcare sector.

Healthcare logistics and supply chain management (HLSCM) systems are essential in offering the timely and effective supply of healthcare services (Debnath et al., 2023). HLSCM handles healthcare goods, personnel, and information from suppliers to patients (Ash et al., 2022). safeguarding success through rapid distribution, effective logistics, excellent inventory control, and smooth communication among stakeholders such as healthcare workers and patients (Raj et al., 2024).

With growing environmental and economic concerns, NOPCO's role in facilitating the implementation of sustainable practices ensures that the healthcare supply chain in Saudi Arabia contributes to the Sustainable development goals. NOPCO's approach to supply chain management that includes green procurement, sustainable logistics, and efficient distribution ensures that products and services not only reach the end consumer efficiently, but also align with Saudi Arabia's environmental and economic goals. The healthcare sector, through NOPCO's leadership, embodies the critical intersection of sustainability and supply chain management in enhancing operational and environmental benefits. Healthcare companies and providers are therefore facing additional pressures as their consumers desire sustainable goods and services.

Medical and pharmaceutical product management is a part of the long-term supply chain. It identifies twenty constraints classified into six categories: material, operational, logistics, human, funding, and exogenous factors (Patil et al., 2021).

information enhances supply chain integration and operational efficiency, impacting three key dimensions: hospitals, patients, and suppliers (Yu et al., 2023). To enhance efficiency and decrease costs, the healthcare supply chains have to be modernized through integration, technologies and strategies (Hossain & Thakur, 2021).

The investment government is essential in infrastructure and universal services in urban and privileged areas (Hossain & Thakur, 2021). Shorter lead times add value to customers and increase supply chain reliability, while longer lead times negatively impact competitiveness (Alzoubi et al., 2022).

The World Health Organization (WHO) has defined a sustainable healthcare system as one that improves, maintains, or restores health, while minimizing negative impacts on the environment and taking advantage of opportunities to restore and improve it for the benefit of the health and well-being of present and future generations. Moreover, SSCM in healthcare is a concept that refers to the provision of medical care that meets the health needs of the current population. While it is minimizing negative impacts on the environment, ensuring the availability of resources for future generations, reducing costs, and contributing to increasing revenues through the provision of health services.

Sustainable supply chain management plays a crucial role in protecting the environment and this is reflected in operational and economic performance (Amofa et al., 2023). Global interest has prompted industrial companies to solve environmental problems by shifting to sustainable supply chain management (Khattak et al., 2024). As a result, companies are implementing sustainable sourcing, sustainable manufacturing, environmental conservation initiatives, supplier engagement, green product design, warehousing, logistics optimization, and reverse logistics (Mukhsin and Suryanto, 2022).

Consumers today are becoming more aware, preferring to buy products from companies that comply with supply chain sustainability practices. Therefore, the health sectors in the world and in the Kingdom of Saudi Arabia seek to be the first investors in the application of sustainability through supply chain management. Which means contracting and dealing with logistics companies that apply sustainability to provide their needs of medical products. Operational performance is closely related to that. That will be relevant in this study and appropriate to the healthcare context. It can be said that there is a positive relationship for SSCM and operational performance.

Problem statement:

Despite the increasing global emphasis on sustainable supply chain management (SSCM), there is still a noticeable scarcity of research that specifically addresses the implementation of SSCM practices and their operational outcomes within the Saudi healthcare sector. While national policies such as Saudi Vision 2030 have highlighted environmental and sustainability goals, academic literature has yet to explore in depth how these sustainability initiatives translate into operational performance improvements in critical sectors like healthcare.

Previous studies have examined related themes from different perspectives. For instance, Azma (2020) focused on environmental awareness in Saudi Arabia and its link to sustainable supply chains from an environmental, economic, and social standpoint. Nour (2023) emphasized social sustainability by addressing ethical sourcing and workers' rights in supply chains. Additionally, Ghaffar (2018) demonstrated economic benefits associated with SSCM implementation, such as reduced material procurement and energy costs. However, these studies do not directly examine how SSCM practices—such as green procurement, green distribution, eco-design, and reverse logistics—influence operational performance dimensions like quality, cost efficiency, and flexibility.

As such, there is a clear gap in the literature regarding the practical and measurable impact of SSCM practices on the operational performance of organizations, particularly within the Saudi healthcare supply chain system. The absence of focused research on this topic is significant given the growing need to deliver healthcare services that not only meet rising patient demands but also minimize environmental impact and promote sustainability.

Therefore, this study aims to fill this gap by investigating the relationship between sustainable supply chain management practices and operational performance outcomes in the healthcare sector, using NUPCO as a case study. The study specifically seeks to answer the following main research question:

To what extent do the dimensions of sustainable supply chain management (green procurement, green distribution, eco-design, and reverse logistics) affect the dimensions of operational performance (quality, cost, and flexibility) in the healthcare sector in Saudi Arabia?

Objectives of the study:

The study aims to identify the following:

- Exploring the extent to which the health sector applies sustainable supply chain management.
- Investigating the effect of adoption of sustainable supply chain management practices on operation performance.

Contribution of Study:

Theoretical importance: This research provides academic scientific benefit, as its results are expected to add more clarification to the role of supply chain management in achieving sustainable development, and an increase in the scientific research literature.

Scientific importance: It is represented in arriving at a framework for building a solid foundation for achieving the adoption of sustainable supply chains. This research seeks to contribute to increasing knowledge enrichment in the areas of study related to

sustainable supply chain management so that the results of this research form a strong foundation. Motivation to conduct complementary studies or emulate the same study in different settings or sectors.

Practical importance: It is expected that the results of the research will help those interested and concerned to provide some results and recommendations that may enrich their desires, which will help them make the appropriate decision. The importance of this research lies in providing a model for applying sustainable supply chain management practices and activities, which in turn enhances the objectives of the Ministry of Health, the most important of which is achieving sustainable development.

Research hypothesis:

The main hypothesis of the study is: There is a statistically significant positive relationship between sustainable supply chain management and the operational performance of the supply chain in the health sector of Saudi Arabia. Sub-hypotheses can be derived from this main hypothesis as follows:

H1: There is a statistically significant effect of green procurement on the dimensions of operational performance.

H1.1 There is a statistically significant effect of green procurement on Quality.

H1.2 There is a statistically significant effect of green procurement on Cost.

H1.3 There is a statistically significant effect of green procurement on Flexibility.

H2: There is a statistically significant effect of eco design on the dimensions of operational performance.

H 2.1There is a statistically significant effect of Eco-Design on Quality.

H 2.2There is a statistically significant effect of Eco-Design on Cost.

H 2.3There is a statistically significant effect of Eco-Design on Flexibility.

H3: There is a statistically significant effect of green distribution on the dimensions of operational performance.

H 3.1 There is a statistically significant effect of green distribution on Quality.

H 3.2 There is a statistically significant effect of green distribution on Cost.

H 3.3 There is a statistically significant effect of green distribution on Flexibility.

H4: There is a statistically significant effect of reverse logistics on the dimensions of operational performance.

H 4.1 There is a statistically significant effect of reverse logistics on the Quality.

H 4.2 There is a statistically significant effect of reverse logistics on the Cost.

H 4.3 There is a statistically significant effect of reverse logistics on the Flexibility.

2- Literature Review

Sustainable Supply Chain Management (SSCM)

SSCM refers to the integration of environmental, social, and economic sustainability into supply chain operations. It emphasizes responsible management of procurement, production, and distribution to improve efficiency, reduce environmental impact, and enhance long-term competitiveness. In recent years, attention has shifted from focusing solely on economic and environmental dimensions to a more balanced inclusion of social factors as well (Ahmed et al., 2022).

Green practices such as eco-design, green procurement, reverse logistics, and sustainable distribution are central to SSCM. These practices not only support environmental goals but also enhance operational outcomes such as customer satisfaction, cost reduction, and adaptability (Mugoni et al., 2024).

Importance and Dimensions of SSCM

The importance of SSCM lies in its ability to meet stakeholder expectations, reduce operational risks, and foster innovation. It also helps organizations align with regulatory standards and gain a competitive edge in dynamic markets. The core dimensions adopted in this study include:

- **Ecological Design**: Designing products to minimize waste and maximize recyclability.
- **Green Procurement**: Sourcing from environmentally responsible suppliers.
- **Reverse Logistics**: Managing returned and recyclable materials efficiently.

- **Green Distribution**: Reducing emissions through sustainable transportation and packaging.

These dimensions are especially relevant in the healthcare sector, where efficient, eco-friendly supply chains can directly affect service quality and public health outcomes (Nour et al., 2023; Awan et al., 2021).

Operational Performance (OP)

Operational Performance refers to how well an organization achieves its objectives in terms of cost, quality, and flexibility. In healthcare, it involves delivering high-quality services efficiently while adapting to changing demands and minimizing waste (Kazancoglu et al., 2022).

Dimensions of OP

The key dimensions used in this study are:

- **Cost**: Reducing expenses in procurement, logistics, and operations.
- **Quality**: Ensuring reliable and high-standard services and products.
- **Flexibility**: Adapting to supply chain disruptions or shifts in demand.

Implementing sustainable supply chain practices has been shown to positively impact these operational metrics by improving resource efficiency, enhancing coordination, and increasing responsiveness (Mustaquim et al., 2024; Mugoni et al., 2024).

Summary and Research Gap

While numerous studies highlight the benefits of SSCM, most focus on industrial or manufacturing settings. There remains a gap in research concerning its application in the healthcare sector, especially in centralized systems like NUPCO. This study addresses this gap by analyzing how sustainable supply chain practices influence key operational outcomes in the Saudi healthcare contex

Previous Studies

Recent studies have increasingly explored the relationship between sustainable supply chain management (SSCM) practices and operational performance across various industries and regions. These studies have provided empirical insights into how green initiatives within the supply chain impact efficiency, quality, cost, and flexibility.

Nour et al. (2023) aimed to examine the impact of green practices—–such as green purchasing, green distribution, eco-design, and reverse logistics—–on operational performance. Using a quantitative approach through surveys distributed to industrial firms in the Middle East, the study found significant positive relationships between green practices and enhanced product quality, cost reduction, and improved operational flexibility. The authors recommended wider adoption of eco-design and green purchasing as strategic tools for enhancing operational outcomes.

Ghaderi et al. (2023) investigated the effects of both internal and external SSCM practices on cost reduction and flexibility. Employing Partial Least Squares Structural Equation Modeling (PLS-SEM), the study targeted a sample of manufacturing firms in Iran. Results indicated that sustainable practices significantly reduce operational costs and improve supply chain responsiveness. The study recommended integrating SSCM strategies into core business processes to enhance operational resilience and performance.

Kazancoglu et al. (2022) focused on the role of sustainable supply chain flexibility in responding to disruptions, especially during crises like the COVID-19 pandemic. The study used qualitative methods and case analysis of supply chains in Turkey. It concluded that flexibility within sustainable supply chains enhances responsiveness and operational stability. Recommendations included developing agile transportation and storage strategies to support operational continuity.

Yu and Lin (2024) developed a conceptual model to evaluate SSCM performance using quantitative modeling and survey data from multinational companies. The study highlighted a strong relationship between sustainable practices and operational efficiency, including time and cost performance. The authors advised firms to adopt integrated sustainability metrics that align environmental and operational goals.

Mugoni et al. (2024) assessed the environmental and operational impacts of SSCM practices in companies across Africa and Asia. Using structural equation modeling, the study found that green purchasing, green manufacturing, green distribution, eco-design, and reverse logistics significantly affected environmental performance, but their impact on operational performance was comparatively

limited. The researchers suggested expanding SSCM evaluations to include social and economic aspects alongside operational dimensions.

Abdallah and Al-Ghwayeen (2019) conducted a survey-based study in Jordanian manufacturing firms to explore the relationship between green supply chain management and operational performance. The results confirmed a strong positive correlation between the two, particularly in enhancing product quality and reducing production costs. The study recommended further investment in green procurement and environmental controls to strengthen overall performance.

Similarly, **Afzal and Hanif (2022)** and **Awan et al. (2021)** found that environmentally conscious product design not only reduces energy and material consumption but also enhances adaptability and customer satisfaction. These results align with the current study's findings that eco-design positively affects cost, quality, and flexibility, reinforcing the value of integrating sustainability into product development. Furthermore, **Suryaningrat and Novita (2022)** identified transportation efficiency as a key driver of environmental and cost-related gains in green distribution, although they noted limitations in flexibility—similar to the findings in NUPCO's case. On the other hand, **Mugoni et al. (2024)** and **Sharma et al. (2021)** highlighted that reverse logistics often faces infrastructural and strategic barriers that limit its impact on performance, which corresponds with the limited effect observed in the current research.

Commentary on Previous Studies

Collectively, these recent studies support the notion that SSCM practices contribute positively to operational performance, particularly in terms of cost reduction, quality improvement, and supply chain flexibility. However, several limitations emerge. Many of the studies focused on a single aspect of SSCM or operational performance rather than exploring the holistic interaction between multiple dimensions. Additionally, most were conducted in industrial or manufacturing settings, with limited attention given to the healthcare sector.

More importantly, to the best of the researcher's knowledge, there is a lack of empirical studies conducted within the Saudi healthcare sector that investigate the direct relationship between SSCM practices and operational performance. This is particularly significant given the healthcare sector's complexity and critical need for sustainable, efficient supply chain operations. The current study addresses this gap by focusing on NUPCO, a major healthcare supply chain organization in Saudi Arabia, and aims to provide a comprehensive analysis of how four dimensions of SSCM (green purchasing, green distribution, eco-design, and reverse logistics) affect three core aspects of operational performance (quality, cost, and flexibility).

This novel approach contributes new insights to the field and offers practical implications for healthcare supply chain managers seeking to enhance performance through sustainability.

3- Methodology:

This section outlines the methodological procedures used, including the research design, sampling, data collection, and statistical analysis. The study employed a structured questionnaire to gather quantitative data on SSCM practices and operational performance at NUPCO.

Research Approach:

An investigative and descriptive quantitative approach was adopted. The research utilized a cross-sectional case study, focusing on measuring the impact of SSCM dimensions (green procurement, green distribution, eco-design, reverse logistics) on operational performance outcomes. The approach enables hypothesis testing and statistical validation.

Population and Sample:

The target population consists of approximately 1166 employees from NUPCO. A sample size of 289 was determined using Krejcie and Morgan's formula. A non-random snowball sampling technique ensured representation from various departments and roles. (Krejcie & Morgan, 1970).

Data Collection Method:

Primary data were collected via an electronically distributed questionnaire, while secondary data were obtained from books, articles, and previous studies relevant to SSCM.

Measurement of Variables:

Independent variables (SSCM practices) and dependent variables (quality, flexibility, cost) were measured using validated items from prior research, with responses rated on a 5-point Likert scale. Validity was assessed through factor analysis and Pearson correlation; reliability was confirmed using Cronbach's Alpha.

Questionnaire Design:

The questionnaire includes three parts: demographic information, independent variables (26 items), and dependent variables (16 items), preceded by a cover letter explaining the study's purpose.

Data Analysis Techniques:

Quantitative data from the responses will be analyzed using statistical methods such as mean, standard deviation, regression analysis, and factor analysis to test the research hypotheses. Factor analysis will be used to identify underlying dimensions and validate constructs. Regression analysis will identify significant predictors of organizational performance, while descriptive statistics will provide an overview of data distribution.

Quantitative data will be analyzed using various statistical methods:

- Descriptive Statistics: Mean and standard deviation will provide an overview of the data distribution.
- Regression Analysis: To identify significant predictors of organizational performance.
- pearson correlation: Used primarily to test the validity of constructs rather than correlation.
- Reliability Testing: Cronbach's alpha will be used to assess the reliability of the scales.
- SPSS Software: SPSS software will be used in data analysis.

Reliability and Validity:

1. Internal Validity (Item-Total Correlation)

The internal validity of the questionnaire was examined using Pearson correlation coefficients between each item and its corresponding field total score. All items across the fields demonstrated statistically significant correlations at the 0.05 level or better, indicating strong internal consistency and validity. The correlation coefficients for the items ranged as follows:

Table 1. Summary of Item-to-Total Correlation Coefficients for Each Field

Field	Range of Pearson Correlation Coefficients	Significance Level
Green Procurement	**0.478 – 0.799**	**$p < 0.05$ / $p < 0.01$**
Green Distribution	**0.489 – 0.707**	**$p < 0.01$**
Eco-Design	**0.401 – 0.826**	**$p < 0.05$ / $p < 0.01$**
Reverse Logistics	**0.483 – 0.816**	**$p < 0.01$**
Quality	**0.744 – 0.868**	**$p < 0.01$**
Cost	**0.412 – 0.901**	**$p < 0.05$ / $p < 0.01$**
Flexibility	**0.546 – 0.892**	**$p < 0.01$**

These results confirm that each item measures the intended construct reliably.

2. External Validity (Field-to-Total Correlation)

External validity was assessed by correlating each field with the total score of the related construct. All fields showed strong and statistically significant correlations ($p < 0.01$), ranging from 0.629 to 0.883.

Table 2. Pearson Correlation Coefficients Between Each Field and Its Overall Construct

Construct	Field	Pearson Correlation
Sustainable SCM	Green Procurement	0.629
	Green Distribution	0.758
	Eco-Design	0.654
	Reverse Logistics	0.742
Operational Performance	Quality	0.761
	Cost	0.851
	Flexibility	0.883

These results indicate that each field significantly contributes to the overall construct it represents.

3. Reliability (Internal Consistency)

The reliability of the questionnaire was assessed using Cronbach's Alpha, which measures internal consistency. All values exceed the acceptable threshold of 0.60, indicating good reliability across all fields.

Table 3. Cronbach's Alpha Coefficients for the Questionnaire Fields

Construct	Field	No. of Items	Cronbach's Alpha
Sustainable SCM	Green Procurement	6	0.629
	Green Distribution	7	0.758
	Eco-Design	7	0.654
	Reverse Logistics	6	0.742
	Total SSCM	26	0.879
Operational Performance	Quality	5	0.761
	Cost	6	0.851
	Flexibility	5	0.883
	Total OP	16	0.845
Overall Questionnaire	All Fields	42	0.832

These alpha values confirm that the questionnaire is reliable and suitable for measuring the intended dimensions.

Characteristics of the Study Sample

The study sample predominantly consisted of male participants (70.1%), reflecting a gender imbalance within the workforce involved in supply chain operations at NUPCO. Regarding job roles, the respondents held a wide range of positions, with a noticeable concentration in logistics-related roles such as Logistics Specialist, Warehouse Supervisor, and Follow-up Officer, underscoring the operational nature of the company. Less common roles like Logistics Manager, Supply Chain Planner, and Procurement Senior Specialist were minimally represented, indicating specialized but limited-position functions. In terms of job experience, nearly half of the participants (48.6%) had less than five years of experience, while 33.9% had between five and ten years, and only 17.4% had more than ten years. This suggests that the sample largely reflects the perspectives of early-career professionals, which may influence their views on the implementation and perception of sustainable supply chain management practices.

Dimensions analysis:

Exploring the extent to which the health sector applies sustainable supply chain management.

This is notice that the level of satisfaction on "supply chain management" is Agree, where the means of the items ranged between 3.26 for "Reverse Logistics " with a relative important index of 65.3%, and 3.63 for "Green Procurement" with a relative important index of 72.6%.

In addition, the total degree of the dimension was 3.41 with a relative important index of 65.3%.

Table 4. Analysis of results for " supply chain management dimensions "

No.	Dimension	M	SD	RII	L
1	Green Procurement	3.63	0.981	72.64	Agree
2	Green Distribution	3.48	1.123	69.72	Agree
3	Eco-Design	3.45	1.051	69.14	Agree
4	Reverse Logistics	3.26	1.207	65.39	Neuter
Total degree		3.41	1.09	69.22	Agree

Hint: M: Mean, SD: Standard Deviation, RII: Relative Important Index, L: Level.

Investigating the effect of adoption of sustainable supply chain management practices on operation performance.

It notices that the level of satisfaction on "operation performance" is Agree, where the means of the items ranged between 3.93 for "Cost " with a relative important index of 78.5%, and 4.07 for "Flexibility" with a relative important index of 81.4%.

In addition, the total degree of the dimension was 3.99 with a relative important index of 79.8%.

Table 5. Analysis of results for " operation performance "

No.	Dimension	M	SD	RII	L
1	Quality	3.97	0.78	79.42	Agree
2	Cost	3.93	0.83	78.58	Agree
3	Flexibility	4.07	0.77	81.48	Agree
Average degree		3.99	0.79	79.83	Agree

Hint: M: Mean, SD: Standard Deviation, RII: Relative Important Index, L: Level.

Hypotheses testing:

Research hypothesis stated that " H1: There is a statistically significant effect of green procurement on the dimensions of operational performance.". These hypotheses tested using Simple Linear Regression.

In Table (6), shows the correlation coefficient R-Square = 0.525, This means 52.5% of the variation in operational performance is explained by the green procurement

Table shows the Analysis of variance for the regression model, F=64.68, Sig.=0.000, so there is a significant relationship between the dependent variable quality and the independent variable green procurement

This table represent effect of green procurement and Quality:

Table 6. Simple linear regression of the Effect of Green Procurement on Quality

Variable	Quality					
	B	T	Sig.	R Square	F	Sig.
Constant	2.373	10.33	0.000	0.512	49.03	0.000
green procurement	.435	7.001	0.000			

There is a statistically significant effect of green procurement on the Quality, the hypothesis is Accept.

H1.2: There is a statistically significant effect of green procurement on the Cost". These hypotheses tested using Simple Linear Regression.

In Table (7), shows the correlation coefficient R-Square = 0.324, This means 32.4% of the variation in Cost is explained by the green procurement

Table shows the Analysis of variance for the regression model, F=66.03, Sig.=0.000, so there is a significant relationship between the dependent variable (Cost) and the independent variable (green procurement).

This table explain effect of green procurement and cost:

Table 7. Simple linear regression model of the effect of green procurement and cost

Variable	Cost					
	B	T	Sig.	R Square	F	Sig.
Constant	1.98	8.19	0.000	0.324	66.03	0.000
green procurement	.532	8.12	0.000			

There is a statistically significant effect of green procurement on the Cost, the hypothesis is Accept

H1.3: There is a statistically significant effect of green procurement on the Flexibility". These hypotheses tested using Simple Linear Regression.

In Table (8), shows the correlation coefficient R-Square = 0.212, This means 21.2% of the variation in Flexibility is explained by the green procurement

Table shows the Analysis of variance for the regression model, F=37.13, Sig.=0.000, so there is a significant relationship between the dependent variable (Flexibility) and the independent variable (green procurement)

This table shows the effect of green procurement and flexibility:

Table 8. Simple linear regression of the effect of green procurement and flexibility

Variable	Flexibility					
	B	T	Sig.	R Square	F	Sig.
Constant	2.58	10.53	0.000	0.212	37.13	0.000
green procurement	.405	6.09	0.000			

There is a statistically significant effect of green procurement on the Flexibility, the hypothesis is Accept.

Research hypothesis stated that " H2: There is a statistically significant effect of green distribution on the dimensions of operational performance "

Sub-hypotheses can be derived from this main hypothesis as follows:

H2.1: There is a statistically significant effect of green distribution on the Quality". These hypotheses tested using Simple Linear Regression.

In Table (9), shows the correlation coefficient R-Square = 0.332, This means 33.2% of the variation in Quality is explained by the green distribution.

Table shows the Analysis of variance for the regression model, F=17.12, Sig.=0.000, so there is a significant relationship between the dependent variable (Quality) and the independent variable (green distribution).

Table 9. Simple linear regression model of effect of green distribution on Quality

Variable	Quality					
	B	T	Sig.	R Square	F	Sig.
Constant	2.814	6.53	0.000	0.332	17.12	0.000
green distribution	.327	4.13	0.000			

There is a statistically significant effect of green distribution on the Quality, the hypothesis is Accept.

H1.2: There is a statistically significant effect of green distribution on the Cost". These hypotheses tested using Simple Linear Regression.

In Table (10), shows the correlation coefficient R-Square = 0.346, This means 34.6% of the variation in Cost is explained by the green distribution

Table shows the Analysis of variance for the regression model, F=18.81, Sig.=0.000, so there is a significant relationship between the dependent variable (Cost) and the independent variable (green distribution).

Table 10. Simple linear regression model of effect of green distribution on Cost

Variable	Cost					
	B	T	Sig.	R Square	F	Sig.
Constant	2.606	8.551	0.000	0.346	18.81	0.000
green distribution	.374	4.33	0.000			

There is a statistically significant effect of green distribution on the Cost, the hypothesis is Accept.

H2.3: There is a statistically significant effect of green distribution on the Flexibility". These hypotheses tested using Simple Linear Regression.

In Table (11), shows the correlation coefficient R-Square = 0.163, This means 16.3% of the variation in Flexibility is explained by the green procurement

Table shows the Analysis of variance for the regression model, F=3.74, Sig.=0.055, so there is a not significant relationship between the dependent variable (Flexibility) and the independent variable (green distribution).

Table 11. Simple linear regression of effect of green distribution on Flexibility

Variable	Flexibility					
	B	T	Sig.	R Square	F	Sig.
Constant	2.82	8.31	0.000	0.212	3.74	0.055
green distribution	.160	1.93	0.055			

There is a not statistically significant effect of green distribution on the Flexibility, the hypothesis is Reject.

Research hypothesis stated that " H3: There is a statistically significant effect of Eco design on the dimensions of operational performance".

Sub-hypotheses can be derived from this main hypothesis as follows:

H3.1: There is a statistically significant effect of co design on the Quality". These hypotheses tested using Simple Linear Regression.

In Table (12), shows the correlation coefficient R-Square = 0.352, This means 35.2% of the variation in Quality is explained by the Eco design

Table shows the Analysis of variance for the regression model, F=19.4, Sig.=0.000, so there is a significant relationship between the dependent variable (Quality) and the independent variable (Eco design).

Table 12. Simple linear regression model of the effect of Eco design on Quality

Variable	Quality					
	B	T	Sig.	R Square	F	Sig.
Constant	2.85	11.33	0.000	0.352	19.4	0.000
Eco design	.317	4.41	0.000			

There is a statistically significant effect of Eco design on the Quality, the hypothesis is Accept.

H3.2: There is a statistically significant effect of Eco design on the Cost". These hypotheses tested using Simple Linear Regression.

In Table (13), shows the correlation coefficient R-Square = 0.374, This means 37.4% of the variation in Cost is explained by the green procurement

Table shows the Analysis of variance for the regression model, F=22.43, Sig.=0.000, so there is a significant relationship between the dependent variable (Cost) and the independent variable (Eco design)

Table 13. Simple linear regression model of the effect of Eco design on cost

Variable	Cost					
	B	T	Sig.	R Square	F	Sig.
Constant	2.631	9.57	0.000	0.374	22.43	0.000
Eco design	.371	4.73	0.000			

There is a statistically significant effect of Eco design on the Cost, the hypothesis is Accept

H3.3: There is a statistically significant effect of Eco design on the Flexibility". These hypotheses tested using Simple Linear Regression.

In Table (14), shows the correlation coefficient R-Square = 0.301, This means 30.1% of the variation in Flexibility is explained by the Eco design

Table shows the Analysis of variance for the regression model, F=37.13, Sig.=0.000, so there is a significant relationship between the dependent variable (Flexibility) and the independent variable (Eco design).

Table 14. Simple linear regression model of the effect of Eco design on Flexibility

Variable	Flexibility					
	B	T	Sig.	R Square	F	Sig.
Constant	3.08	11.61	0.000	0.301	37.13	0.000
Eco design	.281	3.71	0.000			

There is a statistically significant effect of Eco design on the Flexibility, the hypothesis is Accept

Research hypothesis stated that "H4: There is a statistically significant effect of reverse logistics on the dimensions of operational performance".

Sub-hypotheses can be derived from this main hypothesis as follows:

H4.1: There is a statistically significant effect of reverse logistics on the Quality". These hypotheses tested using Simple Linear Regression.

In Table (15), shows the correlation coefficient R-Square = 0.153, This means 15.3% of the variation in Quality is explained by the reverse logistics

Table shows the Analysis of variance for the regression model, F=3.82, Sig.=0.072, so there is not significant relationship between the dependent variable (Quality) and the independent variable (reverse logistics)

Table 15. Simple linear regression of the effect of reverse logistics on Quality

Variable	Quality					
	B	T	Sig.	R Square	F	Sig.
Constant	3.62	19.49	0.000	0.153	3.82	0.072
reverse logistics	.099	1.81	0.073			

There is not statistically significant effect of reverse logistics on the Quality, the hypothesis is Accept.

H4.2: There is a statistically significant effect of reverse logistics on the Cost". These hypotheses tested using Simple Linear Regression.

In Table (16), shows the correlation coefficient R-Square = 0.184, This means 18.4% of the variation in Cost is explained by the green procurement

Table shows the Analysis of variance for the regression model, F=4.82, Sig.=0.030, so there is a significant relationship between the dependent variable (Cost) and the independent variable (reverse logistics).

Table 16. Simple linear regression of the effect of reverse logistics on Cost

Variable	Cost					
	B	T	Sig.	R Square	F	Sig.
Constant	3.47	17.10	0.000	0.184	4.82	0.030
reverse logistics	.131	2.19	0.030			

There is a statistically significant effect of reverse logistics on the Cost, the hypothesis is Accept.

H4.3: There is a statistically significant effect of reverse logistics on the Flexibility". These hypotheses tested using Simple Linear Regression.

In Table (17), shows the correlation coefficient R-Square = 0.052, This means 5.2% of the variation in Flexibility is explained by the reverse logistics

Table shows the Analysis of variance for the regression model, F=0.368, Sig.=0.545, so there is a not significant relationship between the dependent variable (Flexibility) and the independent variable (reverse logistics).

Table 17. Simple linear regression model of the effect of reverse logistics on Flexibility

Variable	Flexibility					
	B	T	Sig.	R Square	F	Sig.
Constant	3.93	20.69	0.000	0.301	0.368	0.545
reverse logistics	.035	0.607	0.545			

There is not statistically significant effect of reverse logistics on the Flexibility, the hypothesis is Accept.

Discussion:

The findings of this study provide substantial evidence supporting the positive role of sustainable supply chain management (SSCM) practices in enhancing operational performance within the healthcare sector, specifically in the context of NUPCO. The significant relationships identified between green procurement, green distribution, and eco-design with operational dimensions such as cost efficiency, quality improvement, and flexibility mirror conclusions reached in several earlier international studies, thereby reinforcing the global relevance of these practices while also contributing unique insights specific to the Saudi healthcare environment.

The strong statistical association between green procurement and operational performance dimensions aligns with the findings of Nour et al. (2023), who emphasized that green procurement reduces waste and fosters long-term relationships with environmentally conscious suppliers, resulting in cost savings and process agility. Within NUPCO, such procurement strategies seem to have positively influenced not just cost efficiency but also the quality of outputs and responsiveness to changing demands. These findings are particularly important considering Saudi Arabia's Vision 2030, which advocates for increased efficiency and sustainability in public sector operations.

Similarly, the impact of eco-design on all three performance dimensions cost, quality, and flexibility demonstrates the effectiveness of integrating sustainability considerations early in the product development lifecycle. The results are consistent with those of Afzal and Hanif (2022) and Awan et al. (2021), who reported that environmentally conscious product design not only reduces energy and material consumption but also enhances adaptability and customer satisfaction. In NUPCO's case, designing products that are easier to recycle or reuse appears to have translated into tangible operational benefits, including reduced operational waste and improved resource utilization.

Green distribution was also found to be significantly related to quality and cost but not to flexibility. This partial support resonates with the work of Suryaningrat & Novita (2022), who identified transportation efficiency as a key driver of environmental and cost-related gains. However, the absence of a significant relationship between green distribution and flexibility suggests structural constraints within NUPCO's logistics system. These could include rigid delivery schedules, limited route options, or a lack of scalable distribution strategies, which may hinder the organization's ability to respond rapidly to changes in demand or emergencies.

On the contrary, reverse logistics showed a limited effect on operational performance, with statistical significance found only in relation to cost. This outcome echoes concerns raised by Mugoni et al. (2024) and Sharma et al. (2021), who highlighted that the success of reverse logistics depends heavily on infrastructure maturity and organizational commitment. In NUPCO's setting, the lack of significance in quality and flexibility dimensions could be attributed to challenges in managing returned goods, limited reuse programs, or underdeveloped recycling systems. These barriers could prevent the reverse flow of goods from contributing effectively to the operational outcomes that the other SSCM dimensions have successfully influenced.

Overall, the discussion of findings underlines a critical insight: the degree of operational benefit derived from SSCM practices is dependent not only on the adoption of these practices but also on the maturity and integration of each practice within the organizational structure. Green procurement and eco-design, for instance, appear to be more systematically embedded within NUPCO's supply chain strategy, while reverse logistics remains underdeveloped or inconsistently applied. This imbalance is likely reflective of broader trends in healthcare supply chains, where sustainability initiatives are often unevenly implemented due to resource, regulatory, or infrastructural limitations.

Moreover, the study's alignment with previous literature reinforces the global applicability of SSCM principles across sectors and regions, while also highlighting the uniqueness of challenges within the Saudi healthcare context. The operational success of SSCM practices at NUPCO, especially in procurement and eco-design, offers a benchmark for other healthcare institutions in the Kingdom aiming to align their operations with Vision 2030 and broader global sustainability goals.

Conclusion:

This study explored the relationship between sustainable supply chain management (SSCM) practices and operational performance in Saudi Arabia's healthcare sector, focusing on NUPCO. Findings revealed that green procurement, eco-design, and green distribution significantly enhanced cost efficiency, quality, and flexibility (except green distribution, which did not significantly affect

flexibility). Reverse logistics had limited influence, impacting only cost. These results underscore SSCM's strategic role in improving performance and supporting national goals such as Vision 2030.

Recommendations

Based on the study findings, the following actions are recommended:

1. Invest in Reverse Logistics: Improve infrastructure and training to enhance efficiency and impact.
2. Enforce Green Procurement Standards: Integrate environmental criteria in supplier evaluations.
3. Institutionalize Eco-Design: Make sustainability a core part of product development.
4. Enhance Flexibility in Green Distribution: Use route optimization and partner with adaptive logistics providers.
5. Align with Vision 2030: Integrate SSCM efforts with national sustainability goals.
6. Encourage Cross-Sector Adoption: Promote SSCM in other industries to expand benefits.
7. Provide SSCM Training: Build awareness and foster a sustainability-driven culture.

Suggestions for Future Research

1. Replicate the study across multiple healthcare institutions for broader insights.
2. Use longitudinal designs to assess long-term SSCM impact.
3. Apply mixed methods to understand cultural and managerial influences.
4. Include variables like environmental performance and patient satisfaction.
5. Compare SSCM practices across sectors (e.g., pharmaceuticals, education).
6. Examine mediators/moderators such as organizational culture or leadership.

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