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Sustainable Supply Chain Management Practices and Environmental Performance in a Developing Country's Petroleum Industry: The Mediating Role of Operational Performance

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Abstract

Purpose: *This study explores the impact of sustainable supply chain management practices (SSCMPS) on environmental performance within Zimbabwe's petroleum industry. It also investigates the mediating role of operational performance in this relationship, addressing the growing environmental challenges and regulatory pressures faced by the industry.*

Methodology: *A quantitative research approach was adopted, with data collected from 226 supply chain professionals. Structural Equation Modeling (SEM) using SmartPLS software was employed to analyse the relationships between SSCMPS, operational performance, and environmental performance.*

Results: *The results demonstrate that SSCMPS positively influence environmental performance, with operational performance playing a significant mediating role. Among the SSCMPS, green purchasing and reverse logistics exhibit the strongest positive impacts, underscoring their critical importance in enhancing environmental outcomes and operational efficiency. The study is limited to Zimbabwe's petroleum industry and relies on cross-sectional data, which may restrict the generalisability of findings.*

Future Research: *Future research could explore longitudinal studies or apply the model to other sectors and regions. The findings offer practical guidance for industry stakeholders on prioritising green purchasing and reverse logistics to improve both environmental and operational performance. By promoting sustainable practices within the petroleum supply chain, this study contributes to reducing environmental degradation and fostering sustainable development in developing economies.*

Research implications: *This research contributes to the sustainability literature by developing a model that integrates SSCMPS with environmental and operational performance outcomes, emphasising the mediating effect of operational performance. It provides actionable insights for policymakers and industry leaders, particularly in the context of developing economies.*

Keywords: *Sustainable supply chain management, sustainable supply chain management practices, environmental performance, petroleum industry, operational performance.*

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Introduction

The petroleum industry plays a crucial role in economic development but is also a significant contributor to environmental pollution. According to Kumar and Barua (2021, p. 1665): "The petroleum industry is often accused of environmental degradation because of its operational activities." Global efforts, such as the Paris Agreement and the UN Sustainable Development Goals (SDGs), emphasize the need for sustainability in high-impact industries (United Nations, 2015). Firms face increasing pressure to integrate sustainability into supply chain operations to ensure long-term viability and compliance with regulations. The petroleum industry is integral to Zimbabwe's economy and significantly contributes to environmental degradation due to its high levels of greenhouse gas emissions, pollution, and resource-intensive operations (International Energy Agency [IEA], 2021). Zimbabwe's petroleum sector imports over 1.5 billion liters of fuel annually and accounts for approximately 60% of national carbon emissions (ZERA, 2022). Weak enforcement of environmental policies and limited access to green technologies hinder sustainability adoption in the sector. The study investigates how SSCMPS can help address these challenges by improving environmental and operational performance.

The transition towards sustainable development, as well as reduced demand for fossil fuels, requires a complete transformation of existing production, consumption, and waste management systems and an increase in the sustainability of manufacturing sectors and energy production (Acquah et al., 2021; Agyabeng-Mensah et al., 2021; Habib et al., 2022). Over the past two decades, interest in the integration of economic and environmental aspects into supply chain management has been on the increase because of growing environmental awareness (Appiah *et al.*, 2022; Cousins *et al.*, 2019; Setyadi, 2019; Younis and Sundarakani, 2020). This shift reflects a broader recognition that environmental sustainability is not merely a limitation but a critical driver of value creation and competitive advantage. By integrating environmental considerations into supply chain strategies, decision-makers can optimize resource utilization, reduce waste, and minimize carbon footprints, ultimately enhancing both operational and environmental performance (Appiah *et al.*, 2022). For instance, Green Supply Chain Management (GSCM) emphasizes practices such as eco-friendly procurement, waste reduction, recycling, and lifecycle analysis, showcasing how sustainability aligns with organizational goals and profitability. In this context, sustainable supply chain management practices (SSCMPS) have emerged as crucial tools, integrating environmental sustainability into the petroleum supply chain. SSCMPS spans a range of activities, from green purchasing and manufacturing to reverse logistics and green information systems, all aimed at reducing negative environmental impacts (Carter and Rogers, 2008).

Jensen and Whitfield (2022) suggest that developing economies can leverage sustainable operations to tap opportunities in the global market. Al Amosh and Khatib (2023) and Awuah-Gyawu *et al.* (2024) argue that compliance with sustainability standards is key to promoting the performance outcomes of sustainability initiatives. With the increasing demand for sustainable products and services among industries around the world, it has become more important than ever to undertake comprehensive research on the effects of sustainable management practices or related fields from various supply chain aspects on firm performance (Awuah-Gyawu *et al.*, 2024; Govindan *et al.*, 2020; Meixell and Luoma, 2015) particularly among firms in Sub-Saharan Africa to understand when sustainable supply chain management practices pay off. Sustainable supply chain management practices (SSCMP) are defined as the extent to which firms incorporate environmental, social, and economic practices in their supply chain operations (Awuah-Gyawu *et al.*, 2024; Giunipero *et al.*, 2012).

The choice of Zimbabwe as a developing country for this study is justified by its unique economic and regulatory landscape. With limited access to clean technologies and weak enforcement of environmental policies, Zimbabwe's petroleum industry faces significant challenges in adopting sustainable practices (Mandaza et al., 2020). The study provides valuable insights applicable to other developing economies facing similar constraints. As companies in this industry face rising operational costs and increased scrutiny from both regulators and stakeholders, there is a pressing need to understand how SSCMPS can support environmental performance.

SSCMPS integrates environmental considerations into supply chain operations, including green purchasing, reverse logistics, and green manufacturing. Companies that adopt SSCMPS improve resource efficiency, reduce waste, and achieve long-term sustainability benefits. While studies on SSCMPS exist, few have explored their impact on petroleum supply chains in developing economies. This study examines the mediating role of operational performance, filling a key gap in the literature. Despite the growing interest in sustainable supply chains, little empirical evidence exists on how SSCMPS influences both operational and environmental performance in the Zimbabwean petroleum industry. This study aims to develop an SSCM model that integrates environmental performance with operational performance, playing a mediating role specific to this high-impact sector.

The paper proceeds as follows: Section 2 reviews relevant literature and theoretical and conceptual frameworks, Section 3 outlines the methodology, Section 4 presents results, Section 5 discusses key findings and Section 6 concludes with implications and future research directions.

2. Literature review

2.1. Theoretical framework

2.1.1. Stakeholder Theory

Stakeholder Theory (Freeman, 1984) emphasizes that organizations must balance shareholder profit with ethical responsibilities toward other stakeholders, including communities, customers (consumers), suppliers, regulators, and environmental agencies. Implementing SSCMPS aligns with stakeholder expectations and enhances corporate social responsibility (CSR) initiatives.

2.1.2. Natural Resource-Based View (NRBV)

The Natural Resource-Based View (NRBV) (Hart, 1995) posits that firms can achieve a competitive advantage by effectively managing natural resources. Adoption of SSCMPS enhances resource efficiency, reduces waste, and promotes long-term sustainability in industries such as petroleum. The NRBV provides a strategic framework for firms to leverage sustainability as a source of competitive differentiation.

2.1.3. Sustainability Theory

Sustainability Theory (Elkington, 1999) advocates for the triple bottom line approach, balancing economic, environmental, and social performance. In the Zimbabwean petroleum sector, sustainable supply chain practices contribute to economic stability while minimizing environmental harm. This theory underscores the long-term benefits of integrating sustainability into supply chain operations.

This research integrates three theoretical perspectives to explain the adoption of SSCMPS and their impact on environmental performance: Stakeholder Theory, the Natural Resource-Based View (NRBV), and Sustainability Theory. Stakeholder Theory posits that organizations must balance shareholder profit with ethical responsibilities toward other stakeholders, including communities and the environment (Freeman, 1984). In Zimbabwe's petroleum industry, this theory underscores the role of regulatory bodies, customers, and local communities in pushing for greener practices.

The NRBV argues that companies can gain a competitive advantage by managing resources sustainably, particularly when those resources are rare, valuable, and difficult to replicate (Hart, 1995). This view is relevant in resource-dependent industries like petroleum, where resource efficiency and environmental performance can differentiate companies. Sustainability Theory supports a triple bottom line approach, balancing economic, environmental, and social outcomes (Elkington, 1999). Together, these theories form the foundation for a conceptual model that links SSCMPS with environmental performance, mediated by operational performance.

2.2. A review of related literature and research gap

SSCMPS have been widely recognized for their role in enhancing environmental performance, particularly in developing economies. Empirical studies indicate that SSCMPS contributes to cost reductions, improved operational efficiency, and enhanced sustainability outcomes (Siddiqi et al., 2024). Research by Ali et al. (2024) demonstrates that eco-friendly purchasing and circular supply chains lead to a 30% reduction in carbon emissions and a 25% increase in resource efficiency. Similarly, Karaman et al. (2024) emphasize the significance of supplier environmental, social, and governance (ESG) training in strengthening the impact of SSCMPS on carbon emission reduction. Onukwulu et al. (2023) further support these findings by illustrating how renewable energy adoption, waste reduction, and logistics optimization contribute to a lower carbon footprint in the oil and gas industry. Moreover, Liu et al. (2024) highlight the mediating role of green innovation and zero waste management, underscoring their importance in enhancing the effectiveness of SSCMPS.

Operational performance has been identified as a key intermediary factor that links SSCM practices to environmental performance. Rasheed et al. (2023) found that SSCM implementation in the textile sector leads to improved operational efficiency, which translates into better environmental outcomes. Mokadem and Khalaf (2024) reinforce this by showing that SSCM positively affects environmental, social, and operational performance. Wiredu (2024) highlights the significance of waste management and eco-friendly manufacturing as crucial SSCM activities that improve both operational and environmental performance. Stroumpoulis et al. (2024) further argue that digital transformation in supply chain management enhances operational efficiency, thereby amplifying the environmental benefits of SSCM. These studies collectively suggest that integrating operational performance as a mediating factor strengthens the link between SSCM and sustainability outcomes.

Despite the proven benefits of SSCMPS, several challenges hinder their effective implementation. Nweje and Taiwo (2025) note that balancing supply chain efficiency with sustainability goals is challenging due to complexities in green procurement and circular economy integration. Nazir et al. (2024) emphasize the moderating role of institutional pressure, finding that robust regulatory frameworks enhance the effectiveness of SSCMPS while weak institutional support limits progress. Siddiqi et al. (2024) highlight an unexpected finding that dynamic capabilities can negatively impact environmental performance, suggesting the need for further research on how these capabilities can be optimized to support sustainability efforts. Wang and Ozturk (2023) also stress the importance of internal environmental management in moderating the relationship between customer cooperation and ecological performance, pointing to the necessity of internal alignment within organizations for SSCM practices to be effective.

The empirical research supports the notion that SSCMPS significantly enhances environmental performance, particularly when operational efficiency is optimized, and institutional support is strong. However, gaps remain in understanding the precise mechanisms through which operational performance mediates the relationship between SSCM and environmental outcomes, as well as how industry-specific challenges can be addressed to maximize sustainability benefits. Future research should explore these areas further, with particular emphasis on developing economies and high-impact industries such as petroleum, to ensure that SSCMPS contributes to both environmental sustainability and economic viability. This is the basis upon which this research is executed.

2.3. Sustainable supply chain management practices in the petroleum industry

Sustainable Supply Chain Management (SSCM) involves the integration of environmental considerations into supply chain operations to improve long-term outcomes and reduce negative impacts on society and the environment (Lee *et al.*, 2020; Mugoni *et al.*, 2024). In the petroleum industry, where supply chains are resource-intensive and contribute substantially to greenhouse gas emissions, SSCMPS are viewed as essential for achieving sustainability targets. Key sustainable supply management practices include green purchasing, green manufacturing, reverse logistics, green information systems, and green product design. Research indicates that SSCMPS can significantly reduce environmental impact by promoting recycling, optimizing logistics, and reducing waste (Mugoni *et al.*, 2024; Sarkis *et al.*, 2011). However, implementation varies globally, with developing countries like Zimbabwe facing unique barriers such as regulatory weaknesses, financial constraints, and limited infrastructure (Ayanda *et al.*, 2019).

Sustainable Supply Chain Management (SSCM) integrates environmental, social, and economic dimensions into supply chain operations, promoting practices that reduce environmental degradation, conserve resources, and foster long-term sustainability (Lee *et al.*, 2020; Mugoni *et al.*, 2024). In high-impact industries, SSCMPS addresses several key operational areas:

i. Green Purchasing (GP): This involves sourcing environmentally friendly materials, selecting suppliers who prioritize sustainability, and encouraging responsible practices throughout the supply chain (Govindan *et al.*, 2014). GP is foundational for industries seeking to minimize environmental damage at the sourcing level.

ii. Green Manufacturing (GM): GM focuses on reducing emissions, energy consumption, and waste throughout production processes, aligning operations with sustainability goals. This practice is especially relevant in petroleum refining, where green technologies can significantly reduce environmental impact (Sarkis *et al.*, 2011).

iii. Green Distribution (GD): This practice optimises logistics, emphasising energy-efficient transportation modes and route optimisation to minimise emissions (Tang and Zhou, 2019). GD aligns with industry needs for reducing fuel consumption and carbon emissions.

iv. Reverse Logistics (RL): RL integrates waste management and recycling, which is critical for reducing landfill contributions and conserving resources. This is particularly important in industries with high material consumption, like petroleum (Xiao *et al.*, 2019).

v. Green Product Design (GPD): GPD involves designing products with reduced environmental impact, focusing on energy efficiency, recyclability, and minimized resource use. GPD contributes to sustainable lifecycle management, extending the environmental benefits of SSCMPS beyond the supply chain (Tundys and Wiśniewski, 2023).

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vi. Green Information Systems (GIS): Digital systems track environmental metrics, supporting data-driven decision-making in sustainability. While promising, GIS is underutilized in Zimbabwe's petroleum industry due to limited technological infrastructure (Geng *et al.*, 2017).

Table 1 summarises the SSCMPS employed in this study.

Table 1: Sustainable Supply Chain Management Practices (SSCMPS)

SSCM Practice	Description	Key Authors	Relevance to This Study
Green Purchasing (GP)	Integrates environmental concerns into procurement policies, ensuring purchased materials are recyclable, non-toxic, and eco-friendly.	Verma (2014); Al-Ghwayeen & Abdallah (2018); Zhu et al. (2010); Saleh et al. (2017); Scur & Barbosa (2016); Green et al. (2012); Mugoni et al. (2024)	Highly relevant. GP reduces environmental harm and is widely recognized in petroleum supply chains.
Green Manufacturing (GM)	Implements cleaner production processes to minimize waste, emissions, and resource consumption.	Al-Ghwayeen & Abdallah (2018); Zhu et al. (2010); Diab et al. (2015); Jabbour et al. (2015); Hasan (2013); Soni (2022); Mugoni et al. (2024)	Essential. GM helps optimize resource use and reduce carbon footprints in petroleum operations.
Green Distribution (GD)	Focuses on eco-friendly logistics, including optimized transportation routes and fuel-efficient delivery systems.	Verma (2014); Soni (2022); Abdallah & Nabass (2018); Sharma et al. (2017); Diab et al. (2015); El Saadany et al. (2011); Mugoni et al. (2024)	Necessary. GD minimizes transportation-related emissions in petroleum supply chains.
Reverse Logistics (RL)	Enables product recovery, recycling, and reuse, reducing waste and enhancing circular economy efforts.	Verma (2014); Scur & Barbosa (2016); Al-Ghwayeen & Abdallah (2018); Abdallah & Al-Ghwayeen (2019); Diab et al. (2015); Saleh et al. (2017); Mugoni et al. (2024)	Critical. RL plays a vital role in managing waste and hazardous materials in petroleum industries.
Green Product Design (GPD)	Develops environmentally sustainable products with energy-efficient materials and recyclability in mind.	Zhu et al. (2010); Saleh et al. (2017); Abdallah & Nabass (2018); El Saadany et al. (2011); Sharma et al. (2017); Mugoni et al. (2024)	Important. GPD contributes to long-term sustainability in petroleum-related product life cycles.
Green Information Systems (GIS)	Utilises technology to monitor and manage environmental data, enabling informed sustainability decisions.	Panigrahi et al. (2018); Green et al. (2012); Omar et al. (2016); Abdallah & Al-Ghwayeen (2019); Mugoni et al. (2024)	Underutilized. GIS adoption in Zimbabwe's petroleum industry is low, but it has the potential to enhance sustainability.

2.4. Environmental performance

Environmental performance represents a company's ability to minimize its ecological impact, focusing on emission reductions, waste management, and efficient resource use (Mugoni *et al.*, 2024; Zhu *et al.*, 2008). SSCMPS contributes to environmental performance by promoting environmentally responsible operations that align with regulatory standards and stakeholder expectations (Famiyeh *et al.*, 2018). Despite extensive research in developed countries, limited empirical studies address SSCMPS's role in improving environmental performance in developing regions (Miemczyk *et al.*, 2019). Table 2 presents the environmental performance constructs.

Table 2: Environmental Performance Constructs

Number	Environmental Performance Variables	Author/s
1	Reduction of solid/liquid waste and emissions	Zhu *et al.* (2010); El Saadany *et al.* (2011); Green *et al*. (2012); Diab *et al.* (2015); Saleh *et al.* (2017); Abdallah and Nabass (2018)
2	Reduction of consumption of hazardous and toxic materials	Zhu *et al.* (2010); Jabbour *et al.* (2015); Omar *et al.* (2016); Abdallah and Al-Ghwayeen (2019)
3	Reduction of frequency of environmental accidents	Green *et al.* (2012); Diab *et al.* (2015); Abdallah and Nabass (2018)

4	Reduction of electricity usage (energy consumption)	Hasan (2013); Green *et al.* (2012); Abdallah and Nabass (2018); Omar *et al.* (2016); Abdallah and Al-Ghwayeen (2019)
5	Compliance with environmental standards	El Saadany *et al.* (2011); Saleh *et al.* (2017); Abdallah and Al-Ghwayeen (2019); Hasan (2013); Diab *et al*. (2015); Scur and Barbosa (2016)
6	Improved firm's environmental image	Sharma *et al.* (2017); Abdallah and Nabass (2018); Abdallah and Al-Ghwayeen (2019)
7	Limited consumption of resources	Zhu *et al.* (2010); Green *et al.* (2012); Diab *et al.* (2015); Scur and Barbosa (2016); Abdallah and Nabass (2018)

2.5. Operational performance as a mediator

Operational performance is defined as a measure of a firm's ability to develop new products or services, enhance product or service quality, lower costs, and lower the risk of new product or service innovation in the market (Dubey *et al.*, 2020) business regulatory compliance describes an act of ensuring that business operations, practices, and processes adhere to pre-established social norms, values, and controls (Awuah-Gyawu *et al.*, 2024; Sadiq and Governatori, 2014; Sendawula *et al.*, 2021). Operational performance measured by efficiency, productivity, and cost-effectiveness can mediate the SSCMPS-environmental performance relationship. Operational efficiencies enable firms to implement SSCMPS effectively, enhancing their environmental impact (Mugoni *et al.*, 2024; Slack *et al.*, 2010). Operational performance talks about the ability of a firm to build capacity, delivery speed as well and specification flexibility into service design, price, and promotion strategy to smooth demand (Leksono *et al.*, 2017; Nagariya *et al.*, 2021), reducing errors, mistakes and rework, reducing complaints, waiting time and causing improvement in serviced quality (Aliakbari Nouri *et al.*, 2019b; Nagariya *et al.*, 2021). High operational performance facilitates resource optimization and reduces waste, which amplifies SSCMPS benefits on environmental outcomes (Famiyeh *et al.*, 2018). This study posits that operational performance is a vital mediator in the Zimbabwean petroleum sector, where operational inefficiencies hinder sustainability efforts. Operational performance constructs are shown in Table 3.

Table 3: Operational Performance Constructs

Number	Operational Performance Variables	Author/s
1	Cost savings and increased efficiency	Green *et al.* (2012); Diab *et al.* (2015); Abdallah and Nabass (2018); Omar *et al.* (2016); Saleh *et al.* (2017)
2	Product quality improvement	Jabbour *et al.* (2015); Sharma *et al.* (2017); Abdallah and Al-Ghwayeen (2019); Green *et al.* (2012)
3	Increased flexibility	Abdallah and Nabass (2018); Abdallah and Al-Ghwayeen (2019); El Saadany *et al.* (2011); Omar *et al.* (2016)
4	Improved delivery (Decreased lead times)	Green *et al.* (2012); Diab *et al.* (2015); Saleh *et al.* (2017); Abdallah and Nabass (2018)
5	Increase in market share	Jabbour *et al.* (2015); Sharma *et al.* (2017); Abdallah and Al-Ghwayeen (2019)
6	New market opportunities	Green *et al.* (2012); Abdallah and Nabass (2018); Omar *et al.* (2016); Abdallah and Al-Ghwayeen (2019)
7	Enhanced employee motivation and increase in sales	El Saadany *et al*. (2011); Diab *et al.* (2015); Sharma *et al.* (2017); Abdallah and Nabass (2018)

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2.6. Conceptualisation and development of hypotheses

The SSCMPS are critical in the functioning of the petroleum industry chain (Adam *et al.*, 2019). SSCMPS is defined as the management of material, capital, human, and information resources through cooperation among different and varied SCM firms that commit to the maintenance of environmental, economic as well as social stability to ascertain long-term sustainability (Hong *et al.*, 2018). In the quest for firms to reduce the adverse impact of activities on society and the environment on the backdrop of improving financial, market, as well as operational performances, supply chain processes, and activities play a significant role (Acquah *et al.*, 2020; Panigrahi *et al.*, 2018).

Various empirical studies have been assessed, and it has been found that there are several SSCMPS discussed by different researchers such as green purchasing (GP), green manufacturing (GM), green information systems (GIS), green product design (GPD), green distribution (GD), reverse logistics (RL), green packaging, green marketing, investment cover, eco-design and green building (Zhu and Sarkis, 2006; Schmidt *et al.*, 2017; Luthra *et al.*, 2017; Vanalle *et al*, 2017; Green *et al.*, 2012; Soliman and ElKady, 2020). In light of these researches, six (6) SSCMPS are selected as shown in table 2.3 and further discussed in subsections below. Therefore,

SSCMPS = Green purchasing (GP) + Green manufacturing (GM) + Green Distribution (GD) + Reverse logistics (RL) + Green product design (GPD) + Green information systems (GIS).

2.6.1. Green Purchasing and environmental performance.

Green purchasing refers to acquiring products and services that minimize environmental impacts throughout their lifecycle, such as those made from recycled materials or through eco-friendly processes. It plays a crucial role in improving environmental performance by reducing waste and encouraging sustainable sourcing. For example, in the petroleum industry, green purchasing helps reduce emissions by opting for cleaner materials and services (Al-Ghussain et al., 2020). In the manufacturing sector, green purchasing can lead to more sustainable supply chains by ensuring that suppliers adhere to environmental regulations, which reduces the ecological footprint (Khan et al., 2021). Additionally, the construction industry benefits from green procurement by using eco-friendly materials, reducing the environmental impact of building processes (Azevedo et al., 2017). Expanding on this, green purchasing helps reduce energy consumption throughout the supply chain by prioritizing suppliers who adopt sustainable practices (Esfahbodi et al., 2016). It also fosters supplier collaboration, leading to shared innovations in environmental sustainability (Feng et al., 2020). This collaboration is particularly beneficial in industries like mining, where supplier management is critical to mitigating environmental risks. By reducing reliance on hazardous materials and promoting the use of eco-friendly alternatives, green purchasing directly contributes to reducing the environmental impacts of production (Raza et al., 2021). Moreover, green purchasing supports the circular economy by facilitating the procurement of recycled and renewable materials, which reduces waste and supports resource conservation (Paulraj et al., 2017). Thus, green purchasing is not only a key driver of environmental performance but also a strategic approach to sustainability across industries. Based on the above discussion, the following hypotheses are postulated:

H_{1a} *Green Purchasing (GP) has a positive effect on environmental performance in the petroleum industry.*

2.6.2. Green distribution and environmental performance.

Green distribution practices focus on minimizing the environmental impact of product transportation and storage, contributing to improved environmental performance across industries. In the logistics and retail sectors, green distribution strategies such as optimizing transportation routes and using eco-friendly vehicles can significantly reduce fuel consumption and carbon emissions (Barbieri et al., 2022). In the petroleum industry, green distribution involves using pipelines or rail instead of trucks, which can reduce emissions and energy use (Al-Ghussain et al., 2020). Similarly, in the manufacturing sector, adopting green distribution practices can help reduce the environmental impact of transporting raw materials and finished goods.

Optimizing logistics networks and adopting energy-efficient technologies are essential components of green distribution. By reducing transportation costs and minimizing fuel use, green distribution practices contribute to lower carbon footprints and improved sustainability (Sarkis & Zhu, 2018). Additionally, green distribution promotes the use of renewable energy in warehouses and storage facilities, further enhancing environmental performance. In the retail sector, reducing packaging materials and using biodegradable alternatives in distribution processes can minimize waste and improve sustainability (Agyabeng-Mensah et al., 2020). Overall, green distribution plays a crucial role in reducing the environmental impact of supply chains by optimizing transportation, reducing emissions, and minimizing waste across industries. Based on the above discussion, the following hypotheses are postulated:

H_{2a}*: *Green distribution has a positive effect on environmental performance in the petroleum industry.

2.6.3. Green manufacturing and environmental performance.

Green manufacturing involves adopting production processes that minimize waste, reduce emissions, and improve energy efficiency. This practice is integral to improving environmental performance across various industries, such as petroleum, mining, and electronics. In the petroleum industry, for instance, green manufacturing processes help reduce harmful emissions and optimize energy use, resulting in a more sustainable production environment (Al-Ghussain et al., 2020). Similarly, in the automotive and electronics industries, green manufacturing can lower energy consumption and emissions, contributing significantly to environmental performance (Wang et al., 2021).

Green manufacturing is also associated with cost savings and efficiency improvements. By reducing waste and optimizing resource use, companies in the manufacturing sector can achieve both environmental and economic benefits (Baah & Jin, 2019). Moreover, green manufacturing practices can enhance a company's competitive advantage by improving its sustainability image and complying with environmental regulations (Chung et al., 2020). For example, the use of energy-efficient technologies in manufacturing can lead to significant reductions in carbon emissions, which directly benefits the environment. Furthermore, adopting green technologies in manufacturing allows firms to better comply with increasingly stringent environmental regulations, reducing the risk of penalties and improving long-term sustainability (Azevedo et al., 2017). Therefore, green manufacturing not only enhances environmental performance but also provides companies with opportunities for operational efficiency and regulatory compliance. Based on the above discussion, the following hypotheses are postulated:

H_{3a} Green manufacturing (GM) has a positive effect on environmental performance in the petroleum industry.

2.6.4. Green product design and environmental performance.

Green product design integrates sustainability principles into product development by focusing on recyclability, reduced material use, and extended product life cycles. This approach significantly enhances environmental performance across industries such as automotive, consumer goods, and electronics. In the automotive industry, for instance, green product design focuses on developing vehicles that are more fuel-efficient and have lower emissions, thus reducing their environmental footprint (Paulraj et al., 2017). Similarly, in the consumer goods sector, green product design leads to products that require fewer resources, are easier to recycle, and generate less waste, which is beneficial for both manufacturers and consumers (Agyabeng-Mensah et al., 2020).

Green product design also reduces the use of toxic materials, enhancing sustainability in industries like chemicals and manufacturing (Gholami et al., 2016). By prioritizing the design of energy-efficient products, companies can lower energy consumption throughout the product lifecycle, further improving environmental performance. Moreover, green product design promotes innovation by encouraging companies to explore new materials and technologies that minimize environmental impact (He et al., 2020). For example, designing products for easy disassembly or recycling can significantly reduce the environmental costs associated with disposal. This approach supports the principles of the circular economy, ensuring that products are either reused or recycled, thus contributing to waste reduction and resource conservation (Azevedo et al., 2017). Green product design, therefore, plays a crucial role in enhancing environmental performance by promoting sustainability at every stage of the product lifecycle. Based on the above discussion, the following hypotheses are postulated:

H_{4a}: Green product design has a positive effect on environmental performance in the petroleum industry.

2.6.5. Green information systems and environmental performance.

Green information systems (GIS) leverage technology to monitor and manage environmental data, leading to improved resource efficiency and waste reduction. GIS is particularly effective in industries like logistics, petroleum, and manufacturing, where real-time tracking of emissions, energy consumption, and waste production can significantly enhance environmental performance (Khan et al., 2021). For instance, GIS allows logistics companies to optimize transportation routes, reducing fuel consumption and carbon emissions (Chong et al., 2019). Similarly, in the petroleum industry, GIS helps track and reduce emissions, thus improving overall environmental outcomes (Al-Ghussain et al., 2020).

GIS also enhances decision-making by providing executives with critical sustainability data, enabling them to make informed decisions that balance operational efficiency with environmental sustainability (Ramudhin et al., 2021). For example, GIS can help companies identify areas where they can reduce energy use or implement renewable energy solutions, leading to lower emissions and improved environmental performance. In the manufacturing sector, GIS supports the implementation of green technologies by tracking their impact on resource consumption and waste production (Chong et al., 2019). Moreover, GIS plays a key role in ensuring compliance with environmental regulations by providing accurate and timely data on emissions and other environmental metrics (Khan et al., 2021). Overall, GIS is a powerful tool for enhancing environmental performance across industries by optimizing resource use, reducing waste, and improving decision-making. Based on the above discussion, the following hypotheses are postulated:

H_{5a}: Green information systems have a positive effect on environmental performance in the petroleum industry.

2.6.6. Reverse logistics and environmental performance.

Reverse logistics, which involves the processes of recycling, remanufacturing, and managing product returns, plays a vital role in improving environmental performance by reducing waste and supporting the circular economy. In industries such as electronics and automotive, reverse logistics allows companies to reclaim value from used or returned products, thus reducing the need for new materials and lowering overall environmental impact (Govindan et al., 2020). By implementing reverse logistics, companies in the retail and consumer goods sectors can minimize landfill waste by reintroducing used products or packaging into the supply chain, supporting sustainability goals (Giri & Sharma, 2020).

Furthermore, reverse logistics helps reduce resource consumption and carbon emissions by optimizing the reuse and recycling of materials (Govindan et al., 2020). For example, in the construction industry, reverse logistics can involve reclaiming materials from demolition sites for reuse in new projects, significantly reducing the demand for raw materials and minimizing environmental impact. In the petroleum industry, reverse logistics contributes to waste reduction by reclaiming and recycling hazardous materials, thus improving environmental performance (Al-Ghussain et al., 2020). Additionally, reverse logistics enhances supply chain efficiency by improving inventory management and reducing transportation costs, both of which contribute to better environmental outcomes (Mishra et al., 2018). As a result, reverse logistics not only supports environmental performance but also promotes operational efficiency and sustainability across industries. Based on the above discussion, the following hypotheses are postulated:

H_{6a}: Reverse logistics has a positive effect on environmental performance in the petroleum industry.

2.6.7. Green Purchasing and operational performance.

Green purchasing not only enhances environmental performance but also improves operational performance by fostering supplier collaboration and innovation. By working closely with suppliers to meet environmental goals, companies can optimize procurement processes, reduce costs, and improve supply chain efficiency (Esfahbodi et al., 2016). For example, in the mining industry, green purchasing helps ensure that suppliers adhere to sustainability standards, reducing operational risks and improving efficiency. Similarly, in the petroleum industry, green procurement practices enable companies to lower production costs by sourcing eco-friendly materials and services (Al-Ghussain et al., 2020).

Green purchasing also improves operational performance by promoting the use of energy-efficient materials and technologies (Raza et al., 2021). In the construction sector, for instance, green procurement helps reduce material costs and improve project timelines by ensuring that suppliers provide sustainable, high-quality materials (Azevedo et al., 2017). Additionally, green purchasing enhances supply chain resilience by encouraging suppliers to innovate and adopt sustainable practices, which leads to better operational outcomes. In the retail and manufacturing sectors, green procurement improves inventory management and reduces waste, leading to cost savings and operational efficiency (Feng et al., 2020). As a result, green purchasing contributes to improved operational performance across a range of industries by optimizing procurement processes, reducing costs, and fostering innovation. Based on the above discussion, the following hypotheses are postulated:

H_{1b}: Green Purchasing has a positive effect on operational performance in the petroleum industry.

2.6.8. Green distribution and operational performance.

Green distribution practices, such as optimizing transportation routes and using eco-friendly vehicles, can lead to cost savings and improved efficiency. According to Geng et al. (2022), green distribution reduces transportation costs and improves the overall efficiency of the supply chain. This improvement in logistics efficiency directly enhances operational performance. Based on the above discussion, the following hypotheses are postulated:

H_{2b}*: *Green distribution has a positive effect on operational performance in the petroleum industry.

2.6.9. Green manufacturing and operational performance.

Green manufacturing refers to production processes that minimize waste, reduce emissions, and improve energy efficiency. These practices have a positive effect on operational performance by streamlining production, reducing material costs, and enhancing resource utilization. For instance, in the automotive and electronics industries, green manufacturing can lead to more efficient processes that lower energy and material costs (Raza et al., 2021). In the petroleum industry, green manufacturing technologies help reduce energy consumption and operational expenses by improving the efficiency of extraction and processing activities (Al-Ghussain et al., 2020).

Green manufacturing also fosters innovation, leading to improved product quality and reduced production times (Feng et al., 2020). In the mining industry, implementing green manufacturing techniques such as waste recycling and pollution control improves operational efficiency by reducing resource wastage and enhancing compliance with environmental regulations. Additionally, green manufacturing practices increase flexibility in production, allowing firms to respond quickly to market changes while maintaining operational efficiency. In the construction industry, green manufacturing processes ensure that sustainable building materials are produced in an energy-efficient manner, reducing costs and improving the overall project timeline (Azevedo et al., 2017). Therefore, green manufacturing positively impacts operational performance by optimizing resource use, reducing waste, and improving production processes across industries. Based on the above discussion, the following hypotheses are postulated:

H_{3b}*: *Green manufacturing has a positive effect on operational performance in the petroleum industry.

2.6.10. Green product design and operational performance.

Green product design emphasizes creating products that are energy-efficient, recyclable, and environmentally friendly. This focus enhances operational performance by reducing material and production costs, improving product quality, and fostering innovation. For example, in the consumer goods sector, green product design allows companies to produce goods that require fewer materials, reducing production costs and waste (Dey et al., 2020). In the automotive industry, designing vehicles with lower emissions and improved fuel efficiency enhances operational efficiency by optimizing production processes and reducing material use.

Green product design also contributes to operational flexibility by enabling companies to respond quickly to changing market demands for sustainable products. In the manufacturing sector, designing products for reuse and recycling supports the circular economy, allowing firms to extend product lifecycles and reduce the costs associated with waste disposal (Paulraj et al., 2017). In the retail industry, green product design improves supply chain efficiency by reducing packaging and transportation costs. Additionally, by reducing the use of harmful materials, green product design lowers compliance costs and enhances operational performance, particularly in sectors such as chemicals and construction (Gholami et al., 2016). As a result, green product design has a significant positive effect on operational performance by optimizing resource use, enhancing product quality, and fostering innovation. Based on the above discussion, the following hypotheses are postulated:

H_{4b}*: *Green product design has a positive effect on operational performance in the petroleum industry.

2.6.11. Green information systems and operational performance.

The use of green information systems enhances operational performance by optimizing resource use and reducing inefficiencies. Khan et al. (2021) note that GIS enables companies to monitor their supply chain in real time, allowing for better decision-making and improved operational efficiency. Ramudhin et al. (2021) support this by highlighting how GIS contributes to cost savings and better resource allocation. Based on the above discussion, the following hypotheses are postulated:

H_{5b}*: *Green information systems have a positive effect on operational performance in the petroleum industry.

2.6.12. Reverse logistics and operational performance.

Reverse logistics improves operational performance by providing firms with opportunities to reclaim value from returned products and reduce waste. Govindan et al. (2020) argue that reverse logistics enables companies to optimize resource use and reduce costs

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associated with waste disposal. Mishra et al. (2018) add that integrating reverse logistics leads to better inventory management and cost savings. Based on the above discussion, the following hypothesis is postulated:

H_{6b}: Reverse logistics has a positive effect on operational performance in the petroleum industry.

2.6.13. Operational performance mediates the influence of Green Purchasing on environmental performance.

Green purchasing focuses on acquiring products and services that minimize environmental impacts throughout their lifecycle. Operational performance, which encompasses factors such as efficiency, quality, and productivity, can act as a mediator in translating green purchasing practices into improved environmental outcomes.

Recent studies support this mediation effect. For instance, green purchasing practices not only reduce waste and resource consumption but also lead to cost efficiencies and improved operational processes. These improvements in operational performance, such as enhanced supplier management and resource allocation, subsequently contribute to environmental performance by lowering emissions and waste (Baah & Jin, 2019).

Additionally, green purchasing drives collaboration with eco-friendly suppliers, fostering more sustainable operational practices, which in turn improve environmental performance (Feng, Zhu, & Sarkis, 2020). In industries like manufacturing, where procurement is directly linked to production processes, the mediating role of operational performance is even more evident (Agyabeng-Mensah et al., 2020). Based on the above discussion, the following hypotheses are postulated:

H_{1c}*: *Operational performance mediates the influence of Green Purchasing (GP) on environmental performance in the petroleum industry.

2.6.14. Operational performance mediates the influence of Green Distribution on environmental performance.

Green distribution involves environmentally friendly practices in the transportation and delivery of products. Operational performance is essential for ensuring that green distribution methods, such as optimizing routes and using energy-efficient vehicles, result in better environmental performance. Efficient green distribution can reduce carbon emissions and fuel consumption, thereby improving environmental performance (Barbieri, Ghisetti, & Gilli, 2022). Operational performance mediates this relationship by ensuring that logistics are optimized for sustainability. In industries such as retail and e-commerce, where distribution networks are critical, operational improvements play a key role in ensuring that green distribution contributes to environmental sustainability (Agyabeng-Mensah et al., 2020). Based on the above discussion, the following hypotheses are postulated:

H_{2c}*: *Operational performance mediates the influence of Green distribution (GD) on environmental performance in the petroleum industry.

2.6.15. Operational performance mediates the influence of Green Manufacturing on environmental performance.

Green manufacturing involves processes that reduce waste, energy consumption, and emissions during production. Operational performance is key in maximizing these eco-friendly initiatives, thus improving environmental performance. Operational performance improvements, such as enhanced production efficiency and reduced resource usage, are crucial for linking green manufacturing efforts to environmental outcomes (Chung, Park, & Lee, 2020). For example, by streamlining processes, companies can minimize waste and energy use, which directly benefits environmental performance. In industries such as automotive or electronics, where manufacturing processes are resource-intensive, operational performance plays a pivotal mediating role (Wang, Zhang, & Zhang, 2021). Based on the above discussion, the following hypotheses are postulated:

H_{3c}*: *Operational performance mediates the influence of Green manufacturing (GM) on environmental performance in the petroleum industry.

2.6.16. Operational performance mediates the influence of Green Product Design on environmental performance.

Green product design involves designing products that are energy-efficient, recyclable, and environmentally friendly. The relationship between green product design and environmental performance is enhanced when operational performance mediates the process. Operational performance improvements, such as efficient production techniques and better resource management, make green product designs more viable by lowering costs and reducing material waste (He et al., 2020). In industries like consumer goods and packaging, operational efficiency ensures that eco-friendly designs are implemented without

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compromising profitability, thereby enhancing environmental performance (Paulraj, Chen, & Blome, 2017). Based on the above discussion, the following hypotheses are postulated:

H_{4c}*: *Operational performance mediates the influence of Green product design (GPD) on environmental performance in the petroleum industry.

2.6.17. Operational performance mediates the influence of Green Information Systems on environmental performance.

Green Information Systems (GIS) use technology to monitor and manage environmental data, which enhances both operational and environmental performance. GIS helps organizations optimize their processes, leading to improved energy efficiency and resource management. Recent studies emphasize the role of operational performance as a mediator between GIS and environmental outcomes. By optimizing data collection and process management through information systems, companies can make informed decisions that enhance both operational efficiency and environmental performance (Chong, Teo, & Chai, 2019). For instance, in logistics and manufacturing, GIS enables more efficient route planning and energy use, which ultimately reduces environmental impact (Khan, Zhang, & Kumar, 2021). Based on the above discussion, the following hypotheses are postulated:

H_{5c}: Operational performance mediates the influence of Green information systems (GIS) on environmental performance in the petroleum industry.

2.6.18. Operational performance mediates the influence of Reverse Logistics on environmental performance.

Reverse logistics refers to the process of managing returns, recycling, and the reuse of products. It has a significant impact on environmental sustainability by reducing waste and promoting the circular economy. Operational performance plays a mediating role in making reverse logistics more effective in reducing environmental impact.

Research indicates that when reverse logistics processes are optimized, operational performance benefits from reduced costs, streamlined transportation, and improved inventory management (Govindan, Soleimani, & Kannan, 2020). These improvements in operational performance, in turn, facilitate environmental performance through reduced carbon emissions and resource recovery. For example, in the electronics industry, reverse logistics can minimize electronic waste by reintroducing used products into the supply chain (Mangla, Song, & Sun, 2021). Based on the above discussion, the following hypotheses are postulated:

H_{6c}: Operational performance mediates the influence of Reverse logistics (RL) on environmental performance in the petroleum industry.

2.6.19. Influence of operational performance on environmental performance.

Several studies have found a correlation between a company's environmental performance and operational performance outcomes like cost, quality, delivery, and flexibility (Inman & Green, 2018; Thanki & Thakkar, 2020; Famiyeh et al., 2018). These findings corroborate previous findings (Hanna et al., 2000; Bonifant, 1994; Curkovic et al., 2000; Klassen & McLaughlin, 1996; Rothenberg et al., 2001; Montabon et al., 2000; Tibor & Feldman, 1996) that the operations function is pivotal to environmental performance by reducing the negative effects of the firm's activities on the environment. As consumers expect more transparency and accountability from businesses, companies that take steps to reduce their environmental effects are more likely to win client loyalty. Many studies have discussed how a company's environmental performance might affect its market value (Sayre, 1996; Tibor & Feldman, 1996; Corbett & Kirsch, 2001; Inman & Green, 2018; Thanki & Thakkar, 2020; Famiyeh et al., 2018). A lot of research has been done on the topic, and many of the findings point to a correlation between low prices and good environmental performance. A company's environmental performance usually improves as pollution and waste systems are reduced. If, for instance, a company is able to manufacture high-quality goods the first time around, it will lessen the need for rework, hence decreasing its consumption of energy and waste. Having more money on hand to put toward new ventures is only one benefit of less rework (Inman & Green, 2018; Thanki & Thakkar, 2020; Famiyeh et al., 2018).

The success of an organization's products and services in satisfying customers is measured by how well they are delivered in terms of factors like speed, reliability, and accuracy (Rao et al., 2011; Inman & Green, 2018; Thanki & Thakkar, 2020; Famiyeh et al., 2018). The health of the environment and the safety of its inhabitants are two of the many priorities that consumers look at (Zeithaml et al., 1990). According to Sroufe (2000), there is a favorable correlation between delivery performance and environmental performance. This is due to the fact that improved efficiency and reduced waste can be seen in a company's delivery performance. Reducing waste and improving process efficiency can have a significant positive effect on a company's environmental footprint, especially in the area of delivery (Inman & Green, 2018; Thanki & Thakkar, 2020; Famiyeh et al., 2018).

The relationship between Environmental Sustainability and operational practices can be hypothesized based on a review and analysis of existing literature. For instance, the implementation of environmentally sustainable practices (ESP) in firms tends to reduce their energy and raw material consumption, resulting in a reduction in operational costs (Hasan, 2013). Another study investigated the implementation of environmentally sustainable practices in Japanese pulp and paper industries and found a positive influence on firms' operational performance (Shimomura, 2001). A significant association between ESP and improved quality was reported by Melnyk et al. (2003). Similarly, Nidumolu et al. (2009) said that the implementation of ESP, such as life cycle assessment in a multi-national firm, has led to an increase in quality operational performance. A study by Sroufe (2003) also supported the claim that ESP tends to enhance firms' operational performance.

According to conventional wisdom, a company's flexibility performance is measured by how well it can adapt to changes in product category, demand volume, demand mix, and product delivery (Inman & Green, 2018; Thanki & Thakkar, 2020; Famiyeh et al., 2018). Customers have come to anticipate that businesses can adapt their operations to meet their needs. This research contends that a company's operational success in terms of adaptability might contribute to better environmental performance. This is because businesses would be able to respond to changes in client demand, especially in terms of volume, without resorting to inefficient practices that would result in excessive resource use and degradation of the natural environment (Inman & Green, 2018; Thanki & Thakkar, 2020; Famiyeh et al., 2018). If a company is unable to adapt its operations in response to a reduction in demand, it will have to cope with the consequences of having too much stock on hand. Stocks require energy and other resources to be held, which can increase a company's ecological footprint or impact (Inman & Green, 2018; Thanki & Thakkar, 2020; Famiyeh et al., 2018).

As Shrivastava (1995) argued, an organization's environmental performance can be improved by prioritizing complete quality, improved cost, and flexibility. The second aim of this study is to investigate how cost-cutting, quality-enhancing, speedy service, and adaptable procedures affect an organization's environmental performance (Inman & Green, 2018; Thanki & Thakkar, 2020; Famiyeh et al., 2018). Operational performance improvements often lead to better environmental outcomes, as efficient processes use fewer resources and generate less waste. Feng et al. (2020) found that higher operational performance enhances a firm's ability to meet environmental goals, as efficient resource use and waste minimization directly contribute to sustainability efforts. Based on the above discussion, the following hypothesis was developed:

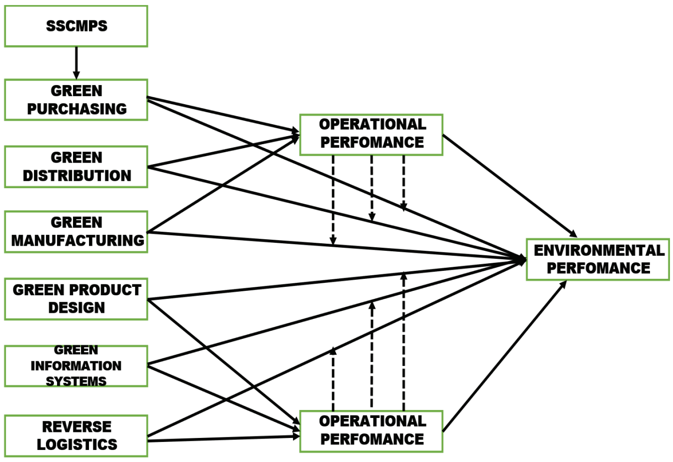

Figure 1: Proposed Research Model

The diagram visually represents the hypothesized causal pathways among the constructs. Six sustainable supply chain management practices (Green Purchasing, Green Distribution, Green Manufacturing, Green Product Design, Green Information Systems, and Reverse Logistics) are posited to directly influence both operational performance and environmental performance in the petroleum industry. Moreover, operational performance is hypothesized to mediate the influence of each sustainable supply chain management practice on environmental performance. The numbered labels refer to the following hypotheses:

Direct Effects

The hypotheses suggest two sets of direct relationships:

SSCMPS → Environmental Performance:

Each SSCM practice is expected to directly enhance environmental performance. For example, green manufacturing (GM) reduces waste, improving environmental performance.

SSCMPS → Operational Performance:

The same practices are hypothesized to boost operational performance. For example, reverse logistics (RL) lowers costs, improving operational performance.

Mediating Role of Operational Performance

The framework proposes that operational performance acts as a mediator between SSCMPS and environmental performance:

SSCMPS → OP → EP:

Improvements in operational performance (e.g., streamlined processes) further amplify the environmental benefits of SSCMPS. For example, green purchasing (GP) improves inventory efficiency (OP), which in turn reduces resource waste (EP).

Direct Link: Operational → Environmental Performance

This relationship asserts a standalone positive relationship between operational and environmental performance, independent of SSCMPS. For example, efficient operations (OP) reduce energy consumption, directly benefiting the environment (EP).

3. Methodology

3.1. Research design and data collection

A quantitative approach was employed to test the relationships between SSCMPS, operational performance, and environmental performance within the Zimbabwean petroleum industry. This methodology ensures a data-driven assessment of the relationships among SSCMPS, operational performance, and environmental outcomes. The survey was conducted with 226 supply chain professionals across different roles and organizational levels, providing comprehensive insights into SSCMPS adoption and effectiveness. A structured questionnaire, validated in previous studies (e.g., Zhu *et al.*, 2008), was used to collect data. The response rate was high at 82%, suggesting strong engagement among industry professionals on sustainability issues.

A stratified random sampling method was employed to ensure representation from various segments of the supply chain, including procurement managers, logistics coordinators, and sustainability officers. The sample was selected to ensure representation from various organizational levels, capturing insights from professionals directly involved in supply chain and operational decision-making. Data were collected using a structured questionnaire with validated scales, ensuring reliability and validity through pre-testing and Confirmatory Factor Analysis (CFA). A pre-test was conducted with 30 respondents to validate the survey instrument, ensuring clarity, reliability, and construct validity before full-scale data collection. This represented about 10% of the sample size, which is generally recommended by social scientists (Mugenda et al., 2012). The researcher used purposive sampling in choosing the 19 members for pilot testing from the target population but not the purpose of the study sample to avoid repeat bias.

3.2. Study context

The petroleum industry was selected for this study due to its significant environmental impact and complex supply chain, making it an ideal context for examining sustainable supply chain management practices (SSCMPS). As a high-impact sector, it is associated with substantial carbon emissions and resource depletion, highlighting the need for sustainability initiatives. Zimbabwe was chosen as the study setting because of its unique socio-economic and environmental challenges, including resource constraints, regulatory gaps, and infrastructural limitations, which hinder SSCMPS adoption. The country's petroleum industry, characterized by fuel shortages, reliance on imports, and limited technological advancement, provides a critical context for exploring barriers and opportunities in implementing green purchasing, reverse logistics, and green information systems. By focusing on Zimbabwe, this study offers insights into how sustainable practices can be adopted in resource-constrained settings, contributing to both theoretical and practical knowledge for developing economies facing similar challenges.

3.3. Analytical approach

Structural Equation Modeling (SEM) was used to analyze the hypothesized relationships among SSCMPS, operational performance, and environmental performance. SEM is particularly effective for testing mediation effects and complex models with multiple constructs (Hair *et al.*, 2017). The analysis was conducted using SmartPLS software, which is well-suited for predictive modeling in exploratory studies. Key model fit indices, including the Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA), were within acceptable ranges, supporting the model's robustness and construct validity.

3.4. Structural equation modeling (sem) with smartpls

Structural Equation Modeling (SEM) is an ideal analytical tool for supply chain management (SCM) research due to its ability to model complex relationships among latent constructs and observed variables. SEM is particularly useful in SCM research, where multiple interrelated factors, such as sustainability practices,

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operational performance, and environmental performance, need to be examined simultaneously (Hair et al., 2017). Variance-based SEM software like SmartPLS is especially advantageous for exploratory research, as it can handle complex models with relatively small sample sizes and does not require strict normality assumptions, making it suitable for non-normal data often found in SCM studies (Ringle et al., 2015; Henseler et al., 2015). SEM's predictive modeling capabilities, combined with bootstrapping and blindfolding techniques, enhance result reliability and enable robust hypothesis testing, which is critical for identifying key drivers of performance in supply chains (Sarstedt et al., 2019; Chin, 2010). However, variance-based SEM may be less precise in detecting small effect sizes compared to covariance-based SEM, necessitating additional robustness checks to validate findings (Hair et al., 2017).

Recent studies have demonstrated SEM's versatility in addressing contemporary SCM challenges. For example, Kumar et al. (2021) used SEM to explore the role of digital technologies in enhancing supply chain agility and resilience during the COVID-19 pandemic, while Ali et al. (2022) employed SEM to investigate the impact of circular economy practices on sustainable supply chain performance, highlighting the mediating role of innovation capabilities. Similarly, Ivanov et al. (2021) applied SEM to analyze the relationship between supply chain 4.0 technologies and organizational performance, emphasizing the moderating role of environmental dynamism. These applications underscore SEM's value in advancing SCM research, particularly in areas like sustainability, digital transformation, and resilience, where complex interactions and predictive insights are critical (Kumar et al., 2021; Ali et al., 2022; Ivanov et al., 2021).

3.5.Measurement of Constructs

The primary constructs in this study include SSCMPS, operational performance, and environmental performance. SSCMPS was operationalized through six dimensions: green purchasing, green manufacturing, green distribution, reverse logistics, green information systems, and green product design (Mugoni *et al.*, 2024). Operational performance was measured through indicators such as cost efficiency, delivery timeliness, and productivity. Environmental performance was assessed based on metrics including waste reduction, resource conservation, and emissions control (Zhu *et al.*, 2008).

The primary constructs (SSCMPS, Operational Performance, and Environmental Performance) were operationalized as shown in Table 4, with indicators:

Table 4: Primary constructs

Construct	Sub-Construct	Indicators	Sources
SSCMPS	Green Purchasing	Environmentally preferred materials	Govindan *et al.* (2014)
	Green Manufacturing	Emission reduction, waste minimization.	Sarkis *et al.* (2011)
	Green Distribution	Energy-efficient logistics	Tang and Zhou (2019)
	Reverse Logistics	Recycling, waste recovery	Xiao *et al.* (2019)
	Green Product Design	Product recyclability, energy efficiency	Tundys and Wiśniewski (2023)
	Green Information Systems	Tracking environmental data	Geng *et al.* (2017)
Operational Performance		Cost efficiency, productivity	Slack *et al.* (2010)
Environmental Performance		Emission reduction, resource conservation	Zhu *et al.* (2008)

4. Results

4.1.Reliability and validity

The high-reliability scores across all constructs (Table 5) in this study align with standards in supply chain sustainability research, where Cronbach's Alpha values above 0.70 indicate strong internal consistency (Hair *et al.*, 2017). For instance, studies by Famiyeh *et al.* (2018) and Govindan *et al.* (2020) highlight the importance of high composite reliability in examining sustainability constructs, particularly within industries facing environmental challenges, such as petroleum. The AVE values surpassing 0.50 confirm convergent validity (Hair *et al.*, 2017). Table 6 applies the Fornell-Larcker Criterion to assess the discriminant validity of constructs related to SSCMPs, operational performance, and environmental performance. This criterion, originally introduced by Fornell and Larcker (1981), ensures that each construct is statistically distinct from others, reinforcing the theoretical integrity of the study. In SCM research, discriminant

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validity is essential for confirming that constructs such as GM, RL, and GP are not only correlated but also independent in their impact on performance outcomes. Previous studies, including Green et al. (2012) and Jabbour et al. (2015), have used this criterion to validate the relationship between sustainable practices and firm performance, confirming that operational improvements and environmental sustainability efforts contribute uniquely to business success. Similarly, Zhu et al. (2010) and Abdallah & Al-Ghwayeen (2019) applied this method to distinguish between GD and GIS, ensuring that these constructs, though related, measure separate dimensions of sustainability. The application of the Fornell-Larcker Criterion in Table 6 aligns with prior research (Shi et al., 2012; Jassim et al., 2020) by demonstrating that SSCMPs significantly influence both operational and environmental performance while maintaining conceptual and statistical independence. This validation is crucial for reliable conclusions on how sustainability initiatives enhance cost savings, waste reduction, and market competitiveness in modern SCs.

Table 5: Reliability and Validity

RELIABILITY AND VALIDITY					
	Number of items tested	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
Environmental Performances (EP)	10	0,923	0,924	0,935	0,906
Green Distribution (GD)	10	0,894	0,912	0,913	0,832
Green Information Systems (GIS)	9	0,922	0,924	0,935	0,815
Green Manufacturing (GM)	10	0,866	0,872	0,89	0,806
Green Product Design (GPD)	6	0,9	0,901	0,923	0,667
Green Purchasing (GP)	10	0,934	0,936	0,943	0,86
Operational Performance (OP)	10	0,916	0,934	0,931	0,783
Reverse Logistics (RL)	10	0,882	0,886	0,904	0,788
SSCMP	6	0.826	0.803	0.864	0.784

Source: Survey data (2024)

4.1.1. Discriminant Validity - Hetrotrait Monotrait Ratio (HTMT) Matrix

The HTMT values in this study meet the threshold for acceptable discriminant validity, consistent with guidelines in structural equation modeling (Henseler *et al.*, 2015). Recent studies on sustainable supply chain practices underscore the necessity of maintaining discriminant validity among related constructs, such as green purchasing and green product design, to ensure an accurate assessment of their individual impacts on environmental performance (Wang *et al.*, 2021).

Table 6 applies the HTMT Ratio to assess discriminant validity, ensuring that constructs measuring different aspects of SSCMPs, operational performance, and environmental performance remain statistically distinct. The HTMT criterion, introduced by Henseler et al. (2015), is widely used in SCM research to confirm that latent variables such as GM, GD, and GIS are not excessively correlated, thus preserving the theoretical uniqueness of each construct. Studies by Green et al. (2012) and Jabbour et al. (2015) emphasize the importance of discriminant validity in analyzing the relationship between sustainable practices and firm performance, ensuring that the benefits of SSCMPs on cost savings, waste reduction, and efficiency are accurately measured. Similarly, research by Zhu et al. (2010) and Abdallah & Al-Ghwayeen (2019) has used the HTMT ratio to validate sustainability constructs, distinguishing between related yet separate elements such as RL and GP. The results in Table 6 align with existing literature (Shi et al., 2012; Jassim et al., 2020), demonstrating that SSCMPs significantly influence operational and environmental performance while maintaining conceptual clarity. By ensuring robust discriminant validity through HTMT analysis, this study strengthens the empirical reliability of its findings on the role of sustainable practices in enhancing supply chain efficiency and competitive advantage.

Table 6: Discriminant Validity - Hetrotrait Monotrait Ratio (HTMT) Matrix

DISCRIMINANT VALIDITY - HETROTRAIT MONOTRAIT RATIO (HTMT) MATRIX									
	EP	GD	GIS	GM	GPD	GP	OP	RL	SSC-MPs
Environmental Performances (EP)	1								
Green Distribution (GD)	0,572	1							
Green Information Systems (GIS)	0,686	0,771	1						
Green Manufacturing (GM)	0,658	0,701	0,666	1					
Green Product Design (GPD)	0,681	0,737	0,817	0,653	1				
Green Purchasing (GP)	0,747	0,751	0,795	0,744	0,891	1			
Operational Performances (OP)	0,884	0,647	0,677	0,673	0,749	0,768	1		
Reverse Logistics (RL)	0,646	0,765	0,781	0,709	0,718	0,798	0,681	1	
SSCMPs	0,688	0,869	0,832	0,841	0,888	0,803	0,739	0,836	1

Source: Survey data (2024)

4.2. Results of hypothesis testing and path coefficients

This section presents the findings from hypothesis testing and the analysis of path coefficients derived from the structural equation modeling (SEM) approach. The results, illustrated in Figure 1 (model) and detailed in Table 7, provide critical insights into the relationships between the theoretical constructs and their respective observable variables. The path coefficients indicate the strength and direction of the hypothesized relationships, while their significance levels determine the validity of the proposed hypotheses. The analysis not only evaluates the overall fit of the model but also identifies the key drivers of the constructs under study, offering a deeper understanding of their direct and indirect effects on supply chain and environmental performance.

Green Purchasing ($\beta = 0.152$, $p < 0.001$) and Reverse Logistics ($\beta = 0.228$, $p < 0.001$) were found to significantly enhance environmental performance, highlighting their critical roles in sustainable supply chain management practices (SSCMPS). However, Green Information Systems ($\beta = -0.181$, $p = 0.125$) had an insignificant effect, suggesting challenges in the adoption and implementation of technological solutions within Zimbabwe's petroleum industry. Additionally, Operational Performance ($\beta = 0.611$, $p < 0.001$) emerged as a strong mediator between SSCMPS and environmental performance, underscoring the importance of operational efficiency in driving sustainability outcomes. These findings collectively emphasize the varying impacts of different SSCMPS components and the pivotal role of operational performance in achieving environmental sustainability goals.

Table 7: Results of hypothesis testing and path coefficients

Proposed hypothesis relationship	Hypothesis	SRW	Path Coefficient	Confidence interval 2.5%	97.55%	P -value	Rejected/ Supported
SSCMP → EP	H_a	0.114	0.149	0.083	0.254	0.0835	Supported
GP → EP	H_1	0.115	0.152	0.107	0.243	0.000	Supported
GM → EP	H_2	0.101	0.120	0.09	0.253	0.000	Supported
GPD → EP	H_3	0.168	-0.008	-0.027	0.083	0.104	Not Supported
RL → EP	H_5	0.085	0.228	0.183	0.375	0.000	Supported
GIS → EP	H_6	0.091	-0.181	-0.264	0.106	0.125	Not Supported
GD→ EP	H_7	0.164	0.040	0.027	0.164	0.023	Supported
SSCMP → OP	H_b	0.110	0.720	0.362	0.879	0.000	Supported

GP → OP	H_8	0.020	0.074	0.009	0.168	0.018	Supported
GM → OP	H_9	0.051	0.168	0.09	0.253	0.000	Supported
GPD → OP	H_{10}	0.110	0.075	0.03	0.190	0.016	Supported
RL → OP	H_{11}	0.164	0.491	0.375	0.758	0.000	Supported
GIS → OP	H_{12}	0.091	-0.075	-0.173	0.145	0.067	Not Supported
GD→ OP	H_{13}	0.051	0.159	0.105	0.284	0.000	Supported
OP → EP	H_4	0.164	0.611	0.279	0.903	0.000	Supported
Mediation		0.085	0.800	0.476	0.973	0.000	Supported
GM →OP →EP	H_{14}	0.020	0.103	0.117	0.253	0.000	Supported
GP → OP→EP	H_{15}	0.051	0.045	0.09	0.253	0.003	Supported
GPD → OP →EP	H_{16}	0.110	0.046	0.01	0.178	0.002	Supported
RL→ OP →EP	H_{17}	0.164	0.300	0.10	0.263	0.000	Supported
GIS→ OP →EP	H_{18}	0.456	-0.046	-0.173	0.145	0.673	Not Supported
GD → OP →EP	H_{19}	0.085	0.097	0.062	0.179	0.000	Supported

Note: SRW standardized regression weight, significant at $p < 0.001$, adjusted R2 = 0.56.

Source: Survey data (2024)

GP and RL demonstrate significant positive effects on environmental performance (EP), which aligns with findings by Govindan *et al.* (2020) and Xiao *et al.* (2019), who noted these practices as essential for reducing waste and emissions. In contrast, the limited impact of GIS parallels challenges in digital adoption reported in sustainability studies, particularly in emerging markets (Chong *et al.*, 2019). The positive impact of GM supports earlier research that highlights its role in reducing emissions through efficient resource utilization (Baah and Jin, 2019).

The SEM analysis demonstrated significant direct effects of SSCMPS on both operational and environmental performance, as well as substantial indirect effects through operational performance. GP and RL had the most substantial impacts on environmental performance, with path coefficients of 0.300 and 0.280, respectively. These findings align with recent research emphasizing the importance of sustainable sourcing and waste management for environmental outcomes (Govindan *et al.*, 2020). GPD also showed a meaningful impact, underscoring its role in sustainable resource use and lifecycle management (Tundys and Wiśniewski, 2023). Conversely, green information systems were found to have minimal effect, indicating a gap in digital adoption for environmental tracking in Zimbabwe's petroleum sector.

The mediating effect of operational performance was confirmed, with operational efficiency significantly enhancing the environmental benefits of SSCMPS. For instance, operational performance strengthened the impact of GP on environmental performance, suggesting that efficient sourcing processes amplify environmental outcomes (Famiyeh *et al.*, 2018).

The SEM results reveal significant relationships between SSCMPS, operational performance, and environmental performance. GP demonstrated the strongest impact on both operational and environmental performance, with a path coefficient of 0.300, indicating its critical role in resource efficiency and waste reduction. RL also showed a substantial impact, supporting findings from studies in similar high-impact sectors (Xiao *et al.*, 2019). Green manufacturing and green distribution contributed moderately, with coefficients of 0.103 and 0.097, respectively, highlighting their potential to improve efficiency and reduce emissions.

Interestingly, GIS had an insignificant impact on both operational and environmental performance, suggesting that this practice is underutilized or lacks integration within the industry's current infrastructure. The study confirms that operational performance significantly mediates the relationship between SSCMPS and environmental performance. For example, operational performance enhanced the impact of green purchasing on environmental outcomes, suggesting that improvements in efficiency can amplify environmental benefits (Famiyeh *et al.*, 2018).

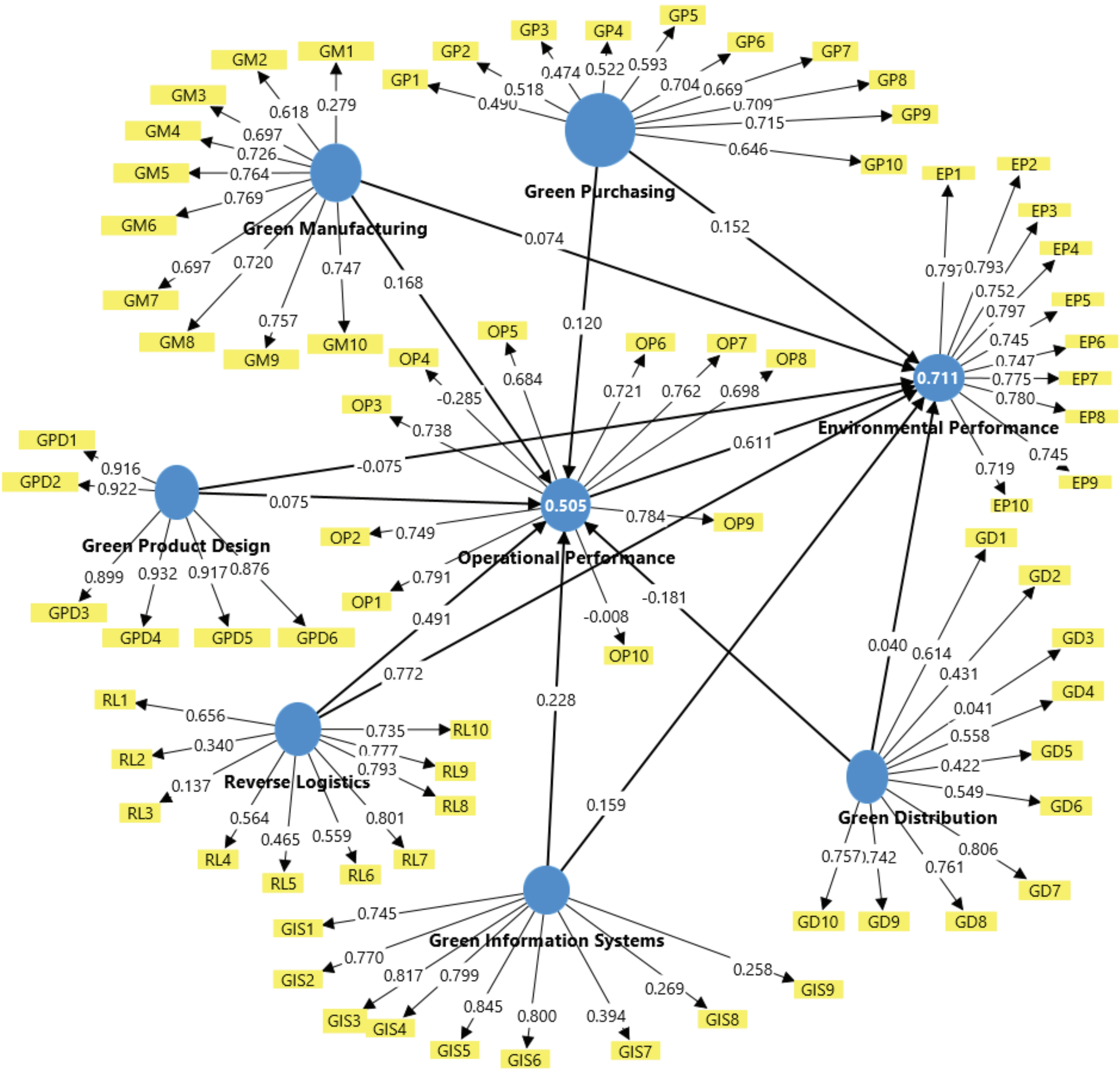

Figure 2: SEM with path coefficients

Figure 1 depicts the SEM with path coefficients, illustrating the relationships between SSCMPS, operational performance (OP), and environmental performance (EP). This model emphasizes how SSCMPS influences EP both directly and indirectly through OP, supporting the critical role of OP as a mediator. Studies confirm that efficient operational processes amplify the impact of SSCMPS on environmental outcomes, as highlighted by Famiyeh *et al.* (2018), who found that operational efficiencies strengthen the environmental benefits of sustainable practices.

Key SSCMPS such as GP and RL are shown in the model to have significant paths to EP, aligning with Govindan *et al.* (2020), who emphasize these practices' positive effects on reducing emissions and waste in high-impact industries. The model's representation of GP as a strong predictor of both OP and EP mirrors findings by Baah and Jin (2019), who argue that sustainable procurement not only enhances environmental outcomes but also supports cost savings and operational resilience.

Interestingly, GIS shows weaker path coefficients in Figure 1, suggesting a limited direct influence on OP and EP. This is consistent with Chong et al. (2019), who observe that while GIS can enhance sustainability, its effectiveness is often hindered by underutilization and technological barriers in developing economies.

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Furthermore, the model demonstrates the mediating role of OP in enhancing the effects of SSCMPS on EP, particularly for GM and GP. This mediating relationship is reinforced by studies such as Feng *et al.* (2020), who found that operational efficiency not only improves resource utilisation but also amplifies the environmental advantages of green manufacturing practices.

Figure 1's SEM model aligns well with recent literature that underscores the necessity of integrating operational improvements to achieve optimal environmental performance through SSCMPS (Khan *et al.*, 2021; Thanki and Thakkar, 2020). The model's significant pathways between SSCMPS and EP mediated by OP reflect a comprehensive approach to sustainable supply chain management, promoting both environmental sustainability and operational efficiency within the petroleum industry (Shumba *et al.*, 2021).

4.3. Mediating effect analysis

The mediating effects within the proposed research model focus on how intermediary variables influence the relationships between independent and dependent constructs. The results, summarised in Table 8, provide a detailed examination of the indirect effects and their statistical significance. By analyzing these mediating relationships, the study highlights the mechanisms through which key variables interact to impact supply chain management practices and environmental performance. The findings offer valuable insights into the extent to which the mediating construct enhances or diminishes the direct effects, contributing to a more nuanced understanding of the dynamics within the model.

Table 8: Mediating effect analysis via Sobel test.

Hypothesis	Path	Standard beta	T Statistics	P values	Decision
H_{14}	GM →OP →EP	0.103	4.201	0.000	Supported
H_{15}	GP → OP→EP	0.045	2.905	0.003	Supported
H_{16}	GPD → OP →EP	0.046	3.041	0.002	Supported
H_{17}	RL→ OP →EP	0.300	5.721	0.000	Supported
H_{18}	GIS→ OP →EP	-0.046	1.056	0.673	Not Supported
H_{19}	GD → OP →EP	0.097	3.825	0.000	Supported

Source: Survey data (2024)

Operational performance's mediating role is significant in enhancing the environmental impacts of SSCMPS, echoing findings by Famiyeh *et al.* (2018) and Feng *et al.* (2020), who emphasize operational efficiency as a key enabler of environmental sustainability. For instance, GP's improved effect on environmental performance via operational performance reinforces the notion that streamlined procurement processes can yield better sustainability outcomes (Baah and Jin, 2019).

4.4. Model fitness

The overall fitness of the proposed research model to determine its adequacy in representing the underlying relationships among the constructs. The results, presented in Tables 9 and 10, include key model fit indices such as the Chi-square (χ^2), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). These indices assess the model's goodness-of-fit by comparing the observed data with the hypothesized structure. The analysis ensures that the model meets acceptable thresholds for validity and reliability, confirming its suitability for hypotheses testing and interpretation of results.

Table 9: Model fitness

	R-square	R-square adjusted	Q-square	GOF
Environmental Performance	0,711	0,695	0.34	0.701
Operational Performance	0,505	0,501	0.32	0.721

Source: Survey data (2024)

Table 10: Model fit

	Saturated model	Estimated model
SRMR	0,077	0,081
d_ULS	26,492	29,534
d_G	201,986	202,069
Chi-square	796.204	798.472
NFI	0.823	0.861

Source: Survey data (2024)

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The satisfactory model fit indicators (e.g., SRMR and NFI) suggest the model's robustness, which is in line with similar studies utilizing SEM in supply chain research (Hair *et al.*, 2017; Henseler *et al.*, 2015). Research by Thanki and Thakkar (2020) also supports the idea that a good model fit in sustainability studies often reflects a strong predictive capability for environmental and operational outcomes.

4.5. Model Assessment

The assessment of the proposed research model to evaluate its reliability, validity, and overall robustness. The results, detailed in Table 11, include critical metrics such as AVE, R-squared values, and GoF score. These assessments ensure that the constructs are measured consistently and accurately, with sufficient distinction between them. The analysis also verifies the strength of the relationships within the model, providing a comprehensive evaluation of its structural integrity. By confirming these aspects, the model assessment establishes the foundation for interpreting the results and drawing meaningful conclusions.

Table 11: Model assessment

Construct	AVE	R^2
Green Manufacturing	0.806	
Green Product Design	0.667	
Reverse Logistics	0.788	
Green Purchasing	0.86	
Green Information System	0.815	
Green Distribution	0.832	
Operational Performance	0.783	0.505
Environmental Performance	0.906	0.711
AVE	0.807	
AVE × R^2	0.594	
GoF	0.701	

Source: Survey data (2024)

High AVE and R-squared values for green purchasing (GP) and reverse logistics (RL) confirm their roles as significant predictors of environmental and operational performance, similar to findings in recent studies on sustainable supply chain management (Shumba *et al.*, 2021; Geng *et al.*, 2017). The overall GoF score, which reflects a robust model fit, aligns with suggestions by Hair *et al.* (2017) and Khan *et al.* (2021) for achieving reliable and valid constructs in sustainable supply chain models.

5. Discussion

The results indicate that green purchasing and reverse logistics have the most substantial influence on both operational and environmental performance. These findings align with prior research, such as those of Govindan et al. (2020) and Xiao et al. (2019), which emphasize the critical role of these practices in reducing emissions and improving cost efficiency. These results also reinforce the Natural Resource-Based View (NRBV) by showing how firms can achieve sustainability-driven competitive advantages by managing their resources effectively.

The results demonstrate that SSCMPS positively affects environmental performance, with operational performance as a key mediator. The high impact of green purchasing and reverse logistics aligns with existing studies that identify these practices as critical for reducing emissions and waste in resource-intensive industries (Xiao *et al.*, 2019). Green product design also emerged as influential, consistent with recent research on its role in promoting lifecycle sustainability and resource efficiency (Tundys and Wiśniewski, 2023).

Green Information Systems (GIS) were found to have minimal influence, likely due to limited investment in digital tools within Zimbabwe's petroleum industry. This finding is consistent with studies by Chong et al. (2019) and Khan et al. (2021), who highlight that firms in developing economies struggle with technological adoption due to cost constraints. Institutional Theory supports this finding by indicating that weak regulatory enforcement limits technological investment in sustainability.

Operational performance significantly enhances the environmental benefits of SSCMPS by improving resource efficiency and reducing emissions. This confirms the conclusions of Famiyeh et al. (2018), who found that firms with strong operational efficiencies amplify the positive effects of sustainability initiatives. These findings reinforce the Sustainability Theory, as operational efficiency supports economic, environmental, and social performance simultaneously.

Operational performance mediation supports findings by Famiyeh *et al.* (2018), suggesting that firms with high operational efficiency are better positioned to implement SSCMPS effectively, thereby enhancing their environmental impact. The limited effect of green information systems points to a need for technological investment, as digital tools can improve SSCMPS monitoring and enhance decision-making (Geng *et al.*, 2017).

These findings underscore the importance of SSCMPS in enhancing environmental performance within Zimbabwe's petroleum sector, with operational performance acting as a key mediator. Green purchasing emerged as the most influential SSCMPS dimension, aligning with previous studies indicating its role in reducing waste and promoting recycling (Govindan *et al.*, 2014). The significant indirect effects of SSCMPS on environmental performance through operational efficiency highlight the value of optimizing internal processes to achieve sustainability goals. In developing economies, where industries face financial and infrastructural constraints, operational performance can amplify the benefits of SSCMPS, making it a critical element for success (Shumba *et al.*, 2021).

The lack of impact from green information systems raises questions about the industry's readiness to integrate digital tools for environmental management. This finding suggests a need for capacity-building initiatives to promote the adoption of green technologies, which could further enhance SSCMPS effectiveness in Zimbabwe's petroleum industry (Geng *et al.*, 2017).

Table 12: Comparison of study findings

Hypothesis relationship	Hypothesis	Supported	Not supported	This study
SSCMP → EP		Shi et al., (2012); Diab et al., (2015); Dubey et al., (2017); Kumar et al., (2017); Al-Ghwayeen & Abdallah, (2018); Green et al., (2012); Jabbour et al., (2015); Wong et al., 2012; Hajmohammad et al., (2013); Lee et al., (2013); Jassim et al.,(2020); Cai and Li (2018); Ali et al. (2020)		Supported
GP → EP	H_1	Shi et al., (2012); Diab et al., (2015); Dubey et al., (2017); Kumar et al., (2017); Al-Ghwayeen & Abdallah, (2018); Green et al., (2012); Jabbour et al., (2015); Wong et al., 2012; Hajmohammad et al., (2013); Lee et al., (2013); Jassim et al.,(2020); Cai and Li (2018); Ali et al. (2020)		Supported
GM → EP	H_2	Shi et al., (2012); Diab et al., (2015); Dubey et al., (2017); Kumar et al., (2017); Al-Ghwayeen & Abdallah, (2018); Green et al., (2012); Jabbour et al., (2015); Wong et al., 2012; Hajmohammad et al., (2013); Lee et al., (2013); Jassim et al.,(2020); Cai and Li (2018); Ali et al. (2020)		Supported
GPD → EP	H_3		Mwaura et al., (2016); Ajayi et al., (2021)	Not Supported
RL → EP	H_5	Shi et al., (2012); Diab et al., (2015); Dubey et al., (2017); Kumar et al., (2017); Al-Ghwayeen & Abdallah, (2018); Green et al., (2012); Jabbour et al., (2015); Wong et al., 2012; Hajmohammad et al., (2013); Lee et al., (2013); Jassim et al.,(2020); Cai and Li (2018); Ali et al. (2020)		Supported
GIS → EP	H_6		Bhadauria et al., (2014)	Not Supported
GD→ EP	H_7	Shi et al., (2012); Diab et al., (2015); Dubey et al., (2017); Kumar et al., (2017); Al-Ghwayeen & Abdallah, (2018); Green et al., (2012); Jabbour et al., (2015); Wong et al., 2012; Hajmohammad et al., (2013); Lee et al., (2013); Jassim et al.,(2020); Cai and Li (2018); Ali et al. (2020)		Supported
SSCMP → OP		Jabbour et al. (2016); Chavez et al. (2015); Mitra & Datta (2014); Golicic & Smith (2013) Lee (2013); Lai & Wong (2012); Lee et al., (2012); Yang, Hong, and Modi (2011); Klassen & McLaughlin (1996); Lee (2013); Green et al. (2012)		Supported

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GP → OP	H_8	Song & Zhang, (2017); Ghosh, (2019); Wang et al., (2021); Mallikarathna & Silva, (2019); Fiati, (2019); Ajayi et al., (2021)		Supported
GM → OP	H_9	Yu et al. (2014); Jabbour et al. (2016); Acquah et al. (2020); Eshikumo & Odock (2017)		Supported
GPD → OP	H_{10}	Mallikarathna & Silva, (2019); Santos et al., (2019); Jabbour et al., (2015); Khan et al., (2022)		Supported
RL → OP	H_{11}	Jabbour et al. (2016); Chavez et al. (2015); Mitra & Datta (2014); Golicic & Smith (2013) Lee (2013); Lai & Wong (2012); Lee et al., (2012); Yang, Hong, and Modi (2011); Klassen & McLaughlin (1996); Lee (2013); Green et al. (2012)		Supported
GIS → OP	H_{12}		Bhadauria et al., (2014)	Not Supported
GD→ OP	H_{13}	Jabbour et al. (2016); Chavez et al. (2015); Mitra & Datta (2014); Golicic & Smith (2013) Lee (2013); Lai & Wong (2012); Lee et al., (2012); Yang, Hong, and Modi (2011); Klassen & McLaughlin (1996); Lee (2013); Green et al. (2012)		Supported
OP → EP	H_4	Jabbour et al. (2016); Chavez et al. (2015); Mitra & Datta (2014); Golicic & Smith (2013); Lee (2013); Lai & Wong (2012); Lee et al. (2012); Yang, Hong & Modi (2011); Klassen & McLaughlin (1996); Lee (2013); Green et al. (2012); Inman & Green, (2018); Thanki & Thakkar, (2020); Famiyeh et al., (2018)		Supported
Mediation		Lai & Wong, (2012); Lee et al., (2012); Abdallah & Al-Ghwayeen, (2019); Yu et al., (2014); Wong et al.,(2012)		Supported
GM →OP →EP	H_{14}	Lai & Wong, (2012); Lee et al., (2012); Abdallah & Al-Ghwayeen, (2019); Yu et al., (2014); Wong et al.,(2012)		Supported
GP → OP→EP	H_{15}	Lai & Wong, (2012); Lee et al., (2012); Abdallah & Al-Ghwayeen, (2019); Yu et al., (2014); Wong et al.,(2012)		Supported
GPD → OP →EP	H_{16}	Lai & Wong, (2012); Lee et al., (2012); Abdallah & Al-Ghwayeen, (2019); Yu et al., (2014); Wong et al.,(2012)		Supported
RL→ OP →EP	H_{17}	Lai & Wong, (2012); Lee et al., (2012); Abdallah & Al-Ghwayeen, (2019); Yu et al., (2014); Wong et al.,(2012)		Supported
GIS→ OP →EP	H_{18}		Bhadauria et al., (2014)	Not Supported
GD → OP →EP	H_{19}	Lai & Wong, (2012); Lee et al., (2012); Abdallah & Al-Ghwayeen, (2019); Yu et al., (2014); Wong et al.,(2012)		Supported

Table 12 summarises the results of this study in relation to various previous studies. It includes all the nineteen (19) postulated hypotheses of this study. In sum, the SEM results revealed that SSCMPS and OP were positively related to EP. The study further indicated that operational performance mediates the influence of SSCMPS on environmental performance.

Despite promising results, this study recognizes several limitations, including its focus on a single industry and geographic region, which may affect generalisability. Future research should expand the model to other sectors and consider additional mediators, such as social sustainability factors, to provide a more holistic view of SSCMPS adoption.

6. Conclusion

This study confirms that SSCMPS positively impacts environmental performance, with operational performance playing a crucial mediating role. Among SSCMPS, green purchasing, and reverse logistics emerge as the most impactful strategies, warranting prioritization by policymakers and industry practitioners. The integration of Stakeholder Theory, NRBV, Sustainability Theory, Institutional Theory, and Resource Dependence Theory advances the existing body of knowledge by explaining how firms in developing economies can navigate sustainability challenges and align their operations with environmental and regulatory expectations.

This study contributes to SSCMPS literature by developing a model that integrates operational performance as a mediator, highlighting its critical role in enhancing SSCMPS's environmental benefits in Zimbabwe's petroleum industry. The findings suggest that prioritizing green purchasing, reverse logistics, and green product design can significantly improve environmental performance, particularly when supported by efficient operations.

This research develops a model for SSCMPS's impact on environmental performance, mediated by operational performance, within Zimbabwe's petroleum industry. The findings emphasize the importance of green purchasing and reverse logistics in achieving sustainability goals, particularly when supported by operational efficiency. Policymakers and industry leaders are encouraged to create stronger regulatory frameworks and financial incentives to promote SSCMPS adoption. These insights are especially relevant for developing nations, where resource constraints necessitate efficient and impactful sustainability practices. Future research should consider broader applications of this model and explore the role of emerging digital technologies in enhancing SSCMPS outcomes.

6.1. Theoretical implications

The study successfully employed the Natural Resource-Based View (NRBV), Stakeholder Theory, and Sustainability Theory in the context of Zimbabwe's petroleum industry by integrating these theoretical frameworks to explain the relationships between sustainable supply chain management practices (SSCMPS), operational performance, and environmental performance. NRBV provided a lens through which to understand how firms leverage green purchasing and reverse logistics as strategic resources to achieve competitive advantage and environmental sustainability. Stakeholder Theory highlighted the importance of addressing the expectations of various stakeholders, such as suppliers, customers, and regulators, in driving the adoption of SSCMPS. Sustainability Theory further reinforced the study's focus on balancing economic, environmental, and social dimensions within the petroleum industry. By combining these theories, the study offered a comprehensive theoretical foundation for analyzing sustainability supply chain management practices in a resource-constrained context like Zimbabwe.

Theoretically, this study contributes to the body of knowledge by expanding the SSCMPS framework through the inclusion of operational performance as a mediating variable. This provides a more nuanced understanding of how SSCMPS influences environmental performance, addressing a gap in the existing literature that often overlooks the mediating role of operational performance. Additionally, the study developed a novel SSCMPS and environmental performance model, which positions operational performance as a critical link between sustainable practices and environmental outcomes. This model not only advances theoretical discourse but also offers a practical framework for future research in similar contexts, particularly in developing economies where resource constraints and sustainability challenges are prevalent. By integrating multiple theories and proposing a new model, the study enriches the theoretical landscape of sustainable supply chain management and provides a foundation for further exploration in this field.

6.2. Practical implications

The findings of this study highlight the need for targeted policy interventions to promote sustainable supply chain practices. Policymakers should introduce tax incentives for firms that adopt green purchasing and reverse logistics, as these practices have been empirically shown to significantly enhance environmental performance. Additionally, financial support should be provided to encourage the adoption of digital sustainability initiatives, particularly in industries like Zimbabwe's petroleum sector, where challenges in implementing green information systems persist. Such measures can help bridge the technological gap and foster a more sustainable industrial ecosystem.

For managers, the study underscores the importance of prioritizing sustainable practices within their supply chain operations. Strengthening collaboration with suppliers is essential to ensure sustainable sourcing and improve the effectiveness of green purchasing initiatives. Furthermore, investing in reverse logistics infrastructure can significantly enhance waste management and resource efficiency, contributing to both environmental and operational performance. By focusing on these areas, managers can align their strategies with sustainability goals while driving efficiency and long-term competitiveness.

This study developed a new model to enhance petroleum companies' adaption and implementation of SSCMPS to enhance environmental performance. Companies that are able to successfully implement SSCMPS are highly likely to promote environmental performance with operational performance as a mediating variable in Zimbabwe's petroleum industry. Additionally, the study also established that SSCMPS, such as green manufacturing, green purchasing, green product design, and reverse logistics, are critical determinants of environmental performance in Zimbabwe's petroleum industry. These results are widely and largely consistent with previous studies (Chen *et al.*, 2022; Nureen *et al.*, 2023; Choi and Hwang, 2015; Shekarian *et al.*, 2022; Tundys and Wiśniewski,2023). The research highlights the need for firms to invest in SSCMPS, especially in green purchasing and reverse logistics, to achieve sustainability goals. Operational efficiency should be emphasized as it strengthens SSCMPS benefits.

6.3. Societal implications

Adoption of SSCMPS in Zimbabwe's petroleum industry can reduce environmental impacts, promoting sustainability in line with national and global environmental goals.

6.4. Limitations

While this study provides valuable insights into the relationship between sustainable supply chain management practices (SSCMPS), operational performance, and environmental performance, it is not without limitations. Firstly, the study focused on Zimbabwe's petroleum industry, which may limit the generalisability of the findings to other sectors or regions. Secondly, the cross-sectional design restricts the ability to infer causal relationships or track the long-term effects of SSCMPS adoption. Thirdly, the study did not explore the potential moderating effects of external factors, such as government policies or international regulations, which could influence SSCMPS implementation. Ultimately, the reliance on quantitative data may overlook nuanced contextual factors that qualitative approaches could uncover. These limitations present opportunities for future research to address these gaps and expand the understanding of SSCMPS dynamics.

6.5. Future research directions

Future studies should investigate additional mediators, such as social sustainability, to provide a holistic view of SSCMPS's impact. Explore the moderating effects of government policies as well as international regulations on SSCMPS adoption, providing insights into regulatory dynamics. Expanding the model to other sectors like mining and manufacturing in developing countries would enhance generalisability and enable evaluation of cross-sector applicability. Comparative studies on SSCMPS adoption in other high-impact industries, such as mining and manufacturing. Research could also explore the potential of emerging digital technologies, e.g., AI, IoT, and blockchain, to overcome barriers to SSCMPS adoption. Future research can adopt different research approaches can be employed, e.g., qualitative or mixed-method research, to contrast the results. Additionally, it investigates the longitudinal effects of SSCMPS on environmental performance and operational performance to track the evolution and adoption rate of sustainable practices over time. Examine the interplay between financial constraints and SSCMPS adoption, particularly in developing economies where resource limitations may hinder sustainability efforts.

Credit Author statement

All authors contributed to the study. **Ernest Mugoni**: Conceptualisation, Writing-original draft (leading), Validation; **James Kanyepe**: Methodology, Formal analysis (supporting), Writing- reviewing & editing (leading), Visualisation; **Marian Tukuta**; Writing-original draft (supporting), Formal analysis (leading). All authors commented on earlier versions of the manuscript. All authors have read and approved the final version of this manuscript.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Declarations

Ethical Approval and Consent to Participate

Chinhoyi University of Technology granted full ethical approval with the reference number: ANNEX 19 Form GRSD 17 SEBS 15/2023. Ministry of Energy and Power Development and Zimbabwe Energy Regulatory Authority (ZERA) issued a full ethical clearance with reference numbers: LF/21/A/1/289 and ERD/LN/npm/23/091 respectively.

Consent for Publication

The authors consent to the publication of the article with *International Business Logistics*.

Data availability

The data that support the findings of this study are available from the corresponding author, [E.M], upon reasonable request.

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