Journal of Infrastructure, Policy and Development 2025, 9(2), 9695.
https://doi.org/10.24294/jipd9695

Article

Sustainable value networks: A focus on operational, environmental, and social performance

Charles Tsikada*, **Rose Luke**, **Joash Mageto**

Department of Transportation and Supply Chain Management, University of Johannesburg, Johannesburg 2092, South Africa
*** Corresponding author:** Charles Tsikada, tsikadac@gmail.com

CITATION

Tsikada C, Luke R, Mageto J. (2025). Sustainable value networks: A focus on operational, environmental, and social performance. Journal of Infrastructure, Policy and Development. 9(2): 9695. https://doi.org/10.24294/jipd9695

ARTICLE INFO

Received: 17 October 2024
Accepted: 7 November 2024
Available online: 6 February 2025

Abstract: Smallholder paprika farmers in Zimbabwe contribute to local economies and food security but face supply chain challenges like limited market access and poor infrastructure which lead to post harvest losses and unpredictable prices. To survive, these farmers must adopt sustainable value networks to reduce operational costs and improve performance. This study sought to establish the effect of sustainable value networks on the operational performance of smallholder paprika farming in Zimbabwe. This study, using a positivist research philosophy and a quantitative approach, surveyed 288 smallholder paprika farmers in Zimbabwe. Exploratory factor analysis and partial least squares structural equation modelling were used to validate the constructs and test the hypothesised relationships. Results demonstrate a moderate level of implementation of value networks in smallholder paprika farming characterised by successes and challenges. The findings illustrated resource sharing among smallholder farmers, facilitated by initiatives, such as recycled seed exchanges and financial support through village savings and loan associations. However, results show that challenges persist, particularly with market access and financial support. Results indicate that there is a significant awareness and implementation of green supply chain management practices among smallholder paprika farmers even though they do not have access to resources and live in rural areas. The findings demonstrate that value networks significantly influence the adoption of green supply chain management practices, which in turn positively impact operational performance, environmental performance, and social performance. Green supply chain management practices were found to mediate the relationship between value networks and environmental performance, social performance, and operational performance, underlining the critical role of sustainable practices in enhancing performance outcomes. While environmental performance showed a positive effect on operational performance, the direct influence of social performance on operational performance was found to be statistically insignificant, suggesting the need for further exploration of the factors linking social benefits to operational efficiency. The research contributes to both theory and practice by presenting a sustainable value network model for smallholder paprika farmers, integrating value network, green supply chain management practices and environmental performance to enhance operational performance. Practical implications include policy recommendations to strengthen collaboration between smallholder farmers and other stakeholdersand address power imbalances with intermediaries. Future research should extend the study to other agricultural sectors and incorporate more diverse stakeholder perspectives to validate and generalise the proposed sustainable value network model.

Keywords: sustainable value networks; green supply chain management practices; operational performance; environmental performance and smallholder paprika farmers

1. Introduction

Smallholder farming is crucial to global food supply chains, contributing to food security and driving economic growth (Tombe and Smuts, 2023). With approximately 570 million smallholder farms worldwide, they produce around 35% of the world’s food supply (FAO, 2022). In regions like South Asia and Southeast Asia, smallholder farmers produce over 80% of the food consumed, supporting rural livelihoods (IFPRI, 2020). In Latin America, they occupy about 34.5% of agricultural land and contribute to 41% of agricultural production (ECLAC, 2021). In Africa, smallholder farms account for about 60% of the agricultural land and contribute up to 70% of the continent’s food supply, thus playing a critical role in food security and poverty reduction (FAO, 2022). In Zimbabwe, smallholder farmers cultivate about 55% of the country’s arable land and contribute approximately 70% of staple food production, including maize (FAO, 2021; ZIMSTAT, 2021). Smallholder paprika farming alone accounts for over 80% of total production, providing employment to about 4,700 households and contributing to both local consumption and exports to international markets like the European Union and South Africa (Mhaka, 2020; Ngezimana, 2021; ZimTrade, 2022). These exports generate foreign exchange earnings, supporting the livelihoods of smallholder farmers and contributing to Zimbabwe’s economic stability. The smallholder agricultural sector plays a vital role in Zimbabwe’s gross domestic product (GDP), with agriculture contributing 17% of the total (World Bank, 2021). Paprika exports generate approximately United State dollars (USD) 12 million annually (ZimTrade, 2022), with farmers earning between USD 1200 and USD 1500 per hectare, 25% more than staple crops like maize and sorghum, which average USD 950 per hectare (AGRITEX, 2021; ZimTrade, 2022). Despite its significance, smallholder farming in Zimbabwe faces several supply chain (SC) challenges, such as unreliable transport, inadequate infrastructure, lack of inputs, and limited access to market information (Jengka, 2020; Langyintuo, 2020; Muzvidziwa, 2021). These challenges hinder the timely delivery of quality produce and limit farmers’ ability to secure fair prices. International markets increasingly require compliance with sustainability standards, which smallholder farmers often struggle to meet due to limited technical knowledge and financial resources.

Adopting a value network (VN) approach could help address this supply chain challenge by fostering collaboration, enhancing information exchange, and improving market access (Lusch and Nambisan, 2015; Porter and Heppelmann, 2014). However, traditional VNs primarily focus on optimising business processes and may not sufficiently address environmental and social challenges. To overcome this, incorporating green supply chain management (GSCM) practices into VNs can form sustainable value networks (SVNs), which promote both operational efficiency and sustainability by integrating eco-friendly practices such as green procurement, logistics, and supplier collaboration (Kumar et al., 2021). SVNs offer numerous benefits, including improved productivity, better market access, and the ability to meet international sustainability standards, which can increase profitability for smallholder farmers (Schoneveld and Weng, 2023; Tangpong et al., 2019). Despite the theoretical potential of SVNs, there remains a gap in understanding how they can be implemented to address the specific challenges faced by smallholder paprika farmers in Zimbabwe, particularly in terms of accessing sustainable markets and improving environmental performance (EP) within their supply chains.

This study seeks to fill this gap by developing a framework for integrating value networks (VNs) and green supply chain management (GSCM) practices to form sustainable value networks (SVNs) for smallholder paprika farmers in Zimbabwe. Smallholder paprika farming in Zimbabwe plays a significant role in local economy and international markets, particularly due to the unique challenges these farmers face, such as market access, resource scarcity, and supply chain inefficiencies. The choice of Zimbabwe allows for a deep exploration of these specific challenges in a context where agriculture contributes substantially to both GDP and employment. While the study focuses on Zimbabwe, the challenges faced by smallholder farmers are common across many developing countries. Therefore, insights gained from Zimbabwe could be applicable to other regions where smallholder farmers face similar supply chain challenges. Paprika farming in Zimbabwe was chosen due to its contribution to both local livelihoods and the export market. Investigating SVNs in this context could enhance resource efficiency, improve market access, and enable smallholder farmers to meet international sustainability standards, thereby improving operational, environmental, and social performance. Given the growing global demand for sustainably produced spices, this research is critical for ensuring the long-term viability and competitiveness of Zimbabwe's paprika sector in international markets.

The study addressed the following research objectives:

1) To determine the level of implementation of value networks in smallholder paprika farming in Zimbabwe.
2) To establish the level of implementation of green supply chain management practices in smallholder paprika farming in Zimbabwe.
3) To determine how value networks influence environmental and social performance through green supply chain management practices in smallholder paprika farming in Zimbabwe.
4) To analyse how green supply chain management practices, environmental performance, and social performance influence the interaction between value networks and operational performance of smallholder paprika farming in Zimbabwe.

The paper is structured into an introduction which outlines the problems and objectives, a literature review defining key concepts, a conceptual framework and hypothesis development, research methods, measurement and structural model assessments, hypotheses testing, discussion, and conclusion with contributions and future research directions**.** The next section provides a theoretical framework underpinning this study.

2. Theory grounding the study

The primary objective of this study is to establish effect of sustainable value networks (SVN) on operational performance (OP) in smallholder paprika farming in Zimbabwe. The theory grounding this study is network theory. Network theory emphasises the importance of interconnectedness, which allows smallholder farmers to access critical resources such as seeds, fertilisers, and pesticides. Farmers can pool resources, procure inputs at better prices, and ensure timely availability which improves productivity. The next section presents the network theory as the theoretical framework underpinning this study.

2.1. Network theory

Network theory provides a more comprehensive perspective for understanding the dynamics of supply chain management (SCM), particularly in contexts where collaboration and external relationships are critical. The theory, as developed by scholars like Hakansson and Ford (2002); Gadde et al. (2003), emphasises the interconnectedness of firms and the role of long-term relationships, partnerships, and collaboration in enhancing resource flows and fostering innovation. Network theory views supply chains not merely as linear sequences of activities but as complex networks of interdependent actors, including suppliers, distributors, customers, and other stakeholders. In a network, each firm represents a cluster of contacts, some of which are useful for other clusters, facilitating the flow of resources, information, and capabilities. The relationships within the network are based on reciprocity and cooperation (Oliver, 1990), and they can lead to improved competitiveness by enabling resource sharing, enhancing innovation, and building trust. In SCM, network theory highlights the importance of building trust-based relationships and fostering long-term collaborations to achieve better performance. For example, firms that are part of a well-functioning network can achieve efficiencies in logistics, share knowledge about market trends, and respond more effectively to changes in the business environment. This theory provides a framework for mapping activities, actors, and resources in a supply chain (Halldorsson et al., 2007), emphasising the value of openness and trust between partners to gain optimal results (Halldorsson et al., 2015). The choice of network theory as the theoretical foundation for this study is based on its ability to capture the complexity and interdependencies in the supply chain of smallholder paprika farmers in Zimbabwe. It provides a more holistic understanding of the relationships and collaborations crucial for smallholder farmers. It highlights the value of partnerships, trust, and collaboration as key elements for optimising resource flows and improving OP in resource-constrained environments. It helps explain how smallholder farmers can benefit from external relationships to access critical resources, markets, and information, thus enhancing their overall supply chain efficiency and competitiveness. This makes network theory the most suitable framework for understanding and addressing the challenges faced by smallholder paprika farmers in Zimbabwe. While network theory offers valuable insights for fostering collaboration and innovation, its application in resource-constrained environments like Zimbabwe can face limitations. Power imbalances and restricted access to resources may hinder long-term partnerships, making it harder for smallholder farmers to fully benefit from interconnected supply chains. The sections below explore the interconnectedness of VNs, GSCM practices, OP, and social performance (SP), emphasising their combined impact on the sustainability and efficiency of smallholder paprika farming in Zimbabwe.

2.2. Value networks and GSCM practices

Value networks (VNs) represent the interconnected relationships among different stakeholders, such as suppliers, customers, and service providers, which help in value co-creation (Christensen and Rosenbloom, 1995; Hakanson and Johanson, 1992; Reinhold et al., 2022). VNs facilitate the collaboration required for GSCM practices by promoting knowledge exchange, providing access to sustainable resources, and enhancing innovation (Castañer and Oliveira, 2020; Ding et al., 2023; Wang and Hu, 2020). VNs create the foundation for adopting GSCM practices, as stakeholders are driven to adopt green practices to reduce environmental impacts and align with consumer demands (Abbasi and Erdebilli, 2023; Valkokar and Rana, 2016). Taner (2023) focused on reducing greenhouse gas emissions through energy optimisation in the dairy farms. The dairy factory's cost savings through energy efficiency underlined the economic benefits of sustainable practices. This interconnected approach not only supports the adoption of sustainable practices but also aligns with broader goals of environmental responsibility and consumer expectations.

2.3. GSCM practices, operational performance, and environmental performance

The integration of green supply chain management (GSCM) practices aims to reduce the environmental impact and improve the efficiency of supply chain (SC) activities, which has been linked to enhanced operational performance (OP) and environmental performance (EP) (Srivastava, 2007; Xu et al., 2022). GSCM practices, such as green procurement, eco-design, and green logistics, are directly related to reducing waste, improving energy efficiency, and achieving cost savings (Aroonsrimorakot and Laiphrakpam, 2024; Laosirihongthong et al., 2013; Wu et al., 2011). Oztuna Taner (2024a) explores the benefits of vacuum freeze-drying technology in food preservation. The study emphasises its positive environmental impact by reducing the need for refrigeration, lowering greenhouse gas emissions, and minimising food waste. Oztuna Taner (2024b) focuses on lowering greenhouse gas emissions in the yoghurt process by enhancing energy efficiency. This supports the overall goal of reducing the ecological footprint across different types of value networks. GSCM practices enhances operational metrics like product quality, delivery reliability, and flexibility which are crucial for smallholder paprika farmers in Zimbabwe to access premium markets and improve profitability.

2.4. Value networks and social performance

Value networks (VNs) play a significant role in shaping the social performance (SP) of organisations by promoting social responsibility, ethical labour standards, and community development (Khaskhelly et al., 2023; Toussaint et al., 2022). For smallholder farmers, VNs can provide access to resources, training, and fair market opportunities, thereby improving their living conditions, healthcare, and education. SP, in turn, enhances community well-being and contributes to long term sustainability (Awan et al., 2018; E-Vahdati et al., 2023).

2.5. Social performance, GSCM practices, and operational performance

The role of social performance (SP) is also linked to both green supply chain management (GSCM) practices and operational performance (OP). GSCM practices enhance SP by reducing negative social and environmental impacts, such as pollution and unsafe labour conditions (Agyabeng-Mensah et al., 2020; Das et al., 2023; Owusu et al., 2019). A well-functioning VN that incorporates GSCM practices can foster better community relations, thereby improving worker productivity, satisfaction, and overall operational efficiency (Bourne et al., 2013; Harter et al., 2002). Thus, SP mediates the relationship between GSCM practices and OP by enhancing the social benefits derived from sustainable practices.

2.6. Mediating role of GSCM practices and SP

This research further investigates the mediating effects of green supply chain management (GSCM) practices and social performance (SP) on the relationship between value networks (VNs) and other performance metrics. While GSCM practices help in transforming the environmental and social dimensions of VNs, SP amplifies their impact by ensuring worker well-being and community engagement, both of which are essential for achieving high OP (Chavez et al., 2022; Ramakrishna and Srivastava, 2024). The next section provides the conceptual framework for this study.

2.7. Conceptual framework

The current study is based on the sustainable value network (SVN) model shown in **Figure 1**. It identifies five constructs: VNs, GSCM practices, OP, EP, and SP. The model includes both direct and indirect relationships, with a total of thirteen hypotheses. Specifically, it hypothesises that the relationship between VNs and OP is mediated by GSCM practices, EP, and SP. The conceptual model clearly illustrates eight direct relationships among these variables. The hypotheses, encompassing VNs, GSCM practices, EP, OP, and SP, are depicted in **Figure 1**.

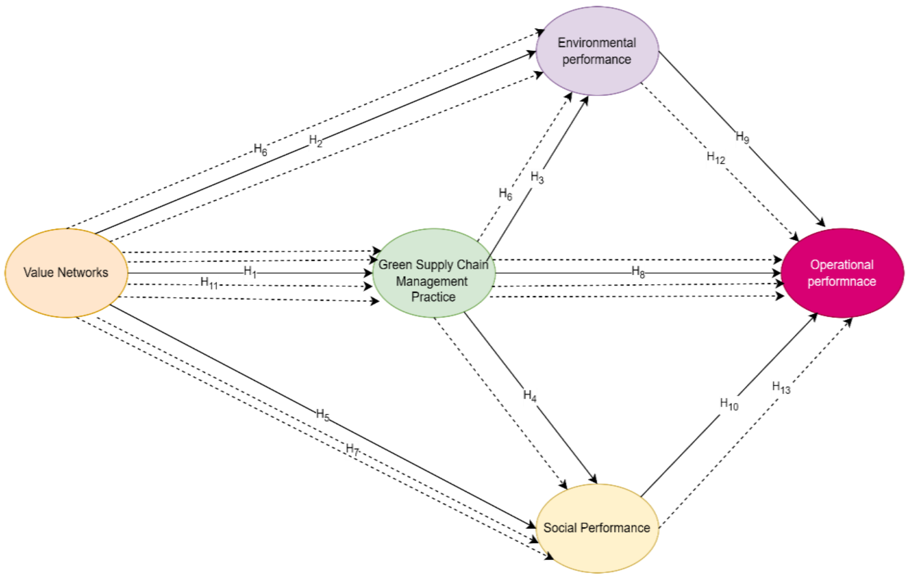

Figure 1. Conceptual framework.

Source: Prepared for this research (2024).

This study sought to test empirically 13 hypotheses using the proposed model, namely:

Hypothesis1: VNs have an effect on the adoption of GSCM practices.

Hypothesis2: VNs have an effect on EP.

Hypothesis3: GSCM practices have an effect on EP.

Hypothesis4: GSCM practices have an effect on SP.

Hypothesis5: VNs have an effect on SP.

Hypothesis6: The effect of VNs on EP is mediated by GSCM practices.

Hypothesis7: The effect of VNs on SP is mediated by GSCM practices.

Hypothesis8: GSCM practices have an effect on OP.

Hypothesis9: EP has an effect on OP.

Hypothesis10: SP has an effect on OP.

Hypothesis11: The effect of VNs on OP is mediated by GSCM practices.

Hypothesis12: The effect of VNs on OP is mediated by EP.

Hypothesis13: The effect of VNs on OP is mediated by SP.

The next section provides the methodology used in this study to collect data from the respondents.

3. Research methods

This study followed a positivism research philosophy, emphasising empirical observation and objectivity. This research philosophy was deemed suitable given that the primary goal was to determine measurable relationships among VNs, GSCM practices, and various performance outcomes. The positivist allows for quantifying the impact of these constructs, thereby providing insights into their influence on smallholder paprika farming performance. A quantitative approach was selected to quantify the relationships between VNs, GSCM practices, and performance outcomes, enabling generalisation to the population of smallholder paprika farmers in Zimbabwe. This facilitated the use of structural equation modelling, which is instrumental in assessing the causal linkages between latent constructs, thereby providing statistical rigor and reliability. The unit of analysis was smallholder paprika farmers in Zimbabwe. A list of 4130 smallholder paprika farmers was extracted from the registers of six paprika schemes provided by the Ministry of Lands, Agriculture, Fisheries, Water, Climate, and Rural Development. A sample size of 352 respondents was determined using both Krejcie and Morgan's (1970) tables and Raosoft sample size calculator. A sample size of 352 provided a high degree of precision and enhanced the reliability of the results. Data was collected using a five-point Likert-type survey questionnaire. The questionnaire was developed by adapting established measurement scales from prior literature, ensuring alignment with the constructs of interest (VNs, GSCM practices, and performance outcomes). Each scale was modified to reflect the unique context of smallholder paprika farming in Zimbabwe, thus ensuring the relevance of the questions. To ensure the reliability and validity of the survey instruments, a pilot test was also conducted with ten respondents to refine the questionnaire. The pilot allowed for identifying any ambiguous questions and determining the appropriateness of the response options. Feedback from the pilot respondents was used to refine the questionnaire by rephrasing unclear items, shortening long questions, and ensuring consistency in the wording of each item. This process enhanced the overall usability of the measuring items. The final questionnaire consisted of sections related to demographics, VNs, GSCM practices, and performance outcomes. A content validity assessment was performed by consulting three professors in the field of agricultural supply chain management to confirm that the questionnaire items adequately captured the theoretical constructs. Reliability was re-verified in this study using internal consistency measures such as Cronbach's alpha and composite reliability during the data analysis phase. Validity was ensured by using construct validity and discriminant validity assessments. For instance, discriminant validity was tested using the HTMT criterion which indicate that the constructs were distinct from one another. **Table 1** provides the measurement scales and their sources.

Table 1. Measurement scales and their sources.

Construct	Sub-construct	Sources
VNs	Actors, roles, resource exchanges, interrelationships, market responses, information flow, governance, distribution channels, and product quality.	Allee et al. (2015); Dentoni and Krussmann (2015); Jin and Doloi (2008); Lissillour et al. (2023); Van der Slikke et al. (2017)
GSCM practices	Green procurement Green packaging	Zhu et al. (2008); Zhu et al. (2010)
EP	Energy consumption Green gas emissions Solid and liquid waste Hazardous and toxic materials	Balasubramanian and Shukla (2017); Bu et al. (2020); Fang and Zhang (2018); Kumar et al. (2015); Rupa and Saif (2022); Shahid et al. (2020); Zhu et al. (2018)
SP	Environmental commitment Farmer well-being Community well-being	Ait Sidhoum et al. (2019); Gimenez and Tachizawa (2012); Huq et al. (2016); Longoni and Cagliano (2016); Piercy and Rich (2015); Qin (2019); Sony et al. (2020); Younis et al. (2016)
OP	Flexibility Delivery Quality Cost saving	Famiyeh et al. (2018); Khan et al. (2022); Mallikarathna and Silva (2019); Yu et al. (2014)

Source: Author (2024).

A purposive sampling technique was employed, and questionnaires were distributed based on pro-rata among six paprika schemes. This was key to mitigate potential sampling biases across the different paprika schemes which ensured adequate representation of various regions. Purposive sampling was selected due to the accessibility and willingness of the farmers to participate, which was essential given the resource constraints and the geographic dispersion of smallholder farms. Partial least squares structural equation modelling (PLS-SEM0 is advantageous when working with non-normal data distributions and smaller sample sizes, which aligned with the nature of the smallholder farming in Zimbabwe. This approach allowed for the simultaneous assessment of both the measurement model, to validate the reliability and validity of constructs, and the structural model, to test the hypothesised relationships between VNs, GSCM practices, and performance outcomes.

Results indicate most respondents are male (63%) compared to female (37%). This reflects broader trends in agriculture where men traditionally play a more prominent role in farm management and operations (Doss, 2018; Njuki et al., 2021; FAO, 2022). The age distribution shows a varied representation across different age groups, with a significant number falling within the 36-45 age range (27%). This suggests that a considerable proportion of respondents were in their prime working years. The majority have secondary education (71%), followed by those with primary education (16%). Higher education levels (Diploma and Degree) are less represented. A formal education beyond the secondary level is less common among paprika farmers in this study. This suggests that most farmers have basic literacy and numeracy skills, which are important for understanding agri supply chain management practices and technologies. A substantial number of respondents have between 5 to 15 years of experience in paprika farming, with 5-10 years being the most common (38%). This implies that most farmers have considerable knowledge and familiarity with paprika farming practices. Majority of respondents are full-time farmers (62.5%), while a significant minority are part-time farmers (37.5%). The section below presents the descriptive statistics of the implementation levels of VNs and GSCM practices.

4. Results

4.1. Descriptive statistics of value networks, green supply chain management practices and performance indicators

This section presents an in-depth analysis of the implementation of value networks (VNs), green supply chain management (GSCM) practices and their effect on performance indicators among smallholder paprika farmers in Zimbabwe. The study aimed to establish the opinions and attitudes of paprika farmers on exchanging resources, responding to market demands, managing relationships, facilitating information flow, and implementing governance structures. **Table 2** presents the results of implementation of value networks, green supply chain management practices, and performance indicators among smallholder paprika farmers in Zimbabwe.

Table 2. Descriptive statistics of value networks, green supply chain management practices, and performance indicators.

Latent variable	Observed variable	Description	Mean	Standarddeviation
Actors, roles and resources exchanges	B1.1	I get inputs, such as seeds, fertilizers, and pesticides from suppliers	4.39	0.659
	B1.2	I get recycled seeds and advice from other smallholder farmers	4.47	0.571
	B1.3	I access funding from village savings and loan associations	4.49	0.528
	B1.4	I get funding from commercial banks	4.52	0.541
	B1.5	I get advice from the extension workers	4.54	0.540
	B1.6	I get funding, advice, and input from donors	4.52	0.540
	B1.7	I have access to the research institutes	4.53	0.595
	B1.8	I access information and advice from mobile services providers	4.59	0.577
Market responses	B2.1	I supply the required quantity of paprika on time	4.57	0.496
	B2.2	I respond to changes in customer tastes and preferences	4.56	0.497
	B2.3	I respond to feedback from buyers on produce quality	4.53	0.565
Relationships	B3.1	I have a long term and stable relationship with farmer groups	4.08	0.438
	B3.2	I have bad experiences with banks	4.08	0.434
	B3.3	I have a good working relationship with donors	4.13	0.440

	B3.4	I have a short-term relationship with input suppliers	4.15	0.425
	B3.5	I sign a contract with spice manufacturing companies	4.07	0.520
	B3.6	I have a short-term relationship with intermediaries	4.12	0.377
	B3.7	I have a distant relationship with the wholesalers, retailers, and final consumers	4.07	0.309
Information flows	B4.1	Intermediaries provide limited information on the product prices (withhold relevant information).	4.44	0.660
	B4.2	I receive information from government extension workers.	4.47	0.672
	B4.3	I receive information on the seeds required from mobile services providers.	4.52	0.636
	B4.4	I receive information on the quality required from farmer groups and exporting firms.	4.50	0.788
	B4.5	Intermediaries has a strong bargaining power since they have access to market information.	4.61	0.615
Governance	B5.1	The government has set high taxes on imported seeds	4.33	0.512
	B5.2	Foreign seeds are tested for many years before being allowed to be used	4.35	0.512
	B5.3	Industrial associations set the voluntary standards through which farmers are required to comply	4.38	0.552
	B5.4	Intermediaries set the prices for the paprika	4.56	0.518
	B5.5	Spice manufacturing companies do not prefer to deal with the individual farmers	4.54	0.499
Product quality	B8.1	I deliver paprika that is free from defects, such as cracks, decay, and sunburn	4.39	0.597
	B8.2	I produce the paprika that tasted good	4.33	0.651
	B8.3	I produce the paprika with high nutritional value	4.26	0.646
	B8.4	I produce the paprika with the right colour	4.26	0.605
	B8.5	I produce the paprika that can be home cooked and healthy	4.32	0.604
GSCM practices	C1.1	I choose packaging material with minimal impact on the environment	4.33	0.866
	C1.2	l choose suppliers with energy-saving production methods that discharge minimum gases	4.34	0.872
	C1.3	I use raw materials that are environmentally friendly and recyclable which save the environment	4.36	0.673
	C1.4	I consciously avoid actions that cause changes to the climate, water infrastructure, and forestry	4.40	0.721
	C1.5	I choose alternative energy sources in production processes	4.42	0.673
Operational performance	D1.1	I respond quickly to changes in market demand	4.20	0.847
	D1.2	Responding to buyer requirements improves sales and profits	4.20	0.881
	D1.3	My costs of procuring input and raw materials have decreased	4.18	0.844
	D1.4	I comply with the delivery dates and quantities	4.31	0.662
Environmental performance	D2.1	There is a reduction in energy consumption	4.26	0.913
	D2.2	There is a reduction in greenhouse gas emissions	4.35	0.760
	D2.3	There is a reduction of solid and liquid wastes	4.20	0.901
	D2.4	There is a reduction of hazardous and toxic materials	4.25	0.859
Social performance	D3.1	I grow paprika because it is a new source of income for a household	4.16	0.809

D3.2	I get the additional income necessary to keep on farming which reduces the risk of land abandonment	4.13	0.910
D3.3	I have access to basic commodities like food and clothes	4.24	0.673
D3.4	I am not experiencing hunger anymore	4.26	0.708

Source: Author (2024).

In **Table 2**, smallholder farmers' interactions within the value network reveal a high level of collaboration and support from various actors, with mean values exceeding 4.39. Farmers frequently access essential inputs such as seeds, fertilisers, and pesticides, along with advice from fellow farmers. Significant financial support was evident from sources like village savings and loan associations and commercial banks. Information flow within the network was robust, particularly from extension workers and mobile service providers, enabling informed decision-making. Farmers demonstrated high market responsiveness, delivering paprika on time and adapting to customer preferences. While stable relationships with farmer groups and donors were evident, there were challenges in strengthening connections with input suppliers and wholesalers. Although information flows were generally transparent, intermediaries sometimes withheld key information, impacting decision-making. Governance challenges also surfaced, including intermediaries setting paprika prices, high taxes on imported seeds, and lengthy seed testing processes. Despite these hurdles, farmers maintained high product quality, producing defect-free paprika with good taste. Their commitment to GSCM practices was notable, using recyclable materials and alternative energy sources. These efforts boosted OP, though some variability was observed, and contributed to environmental improvements, such as reduced energy consumption and greenhouse gas emissions. Socially, the farmers' increased income reduced land abandonment risks and improved access to basic commodities, reflecting the overall positive impact of sustainable value networks on both economic and social stability within the farming communities. The next section presents the results of EFA of this study.

4.2. Exploratory factor analysis for scale development and dimensional reduction of value networks, GSCM practices, and performance indicators

This section presents the exploratory factor analysis (EFA) conducted to reduce dimensionality and develop reliable scales for evaluating key constructs in the study. The analysis confirmed the suitability of the data for factor analysis, as evidenced by the Kaiser-Meyer-Olkin (KMO) values for all constructs exceeding the acceptable threshold of 0.60 and statistically significant results in Bartlett's tests of sphericity. Most constructs show high internal consistency, with α values ranging from 0.617 to 0.953, indicating reliable measurement across the latent variables. SP had a slightly lower α value but is still within an acceptable range. Item-total correlations reflect the strength of the relationship between each individual item and the total score of the construct. In **Table 3**, item-total correlations range from 0.356 to 0.744. Higher values indicate that items are well-aligned with the overall construct. Most of the items in **Table 3** exhibit moderate to strong correlations, exceeding 0.5, suggesting that the items are consistent with the latent variable they belong to. Inter-item correlations show the relationship between pairs of items within the same construct. This helps to evaluate how closely related or redundant items might be. Inter-item correlations between 0.3 and 0.7 are considered ideal, as they indicate a reasonable level of similarity between items without redundancy. Inter-item correlations in **Table 3** range from 0.237 to 0.577, indicating moderate correlations between the items. These results indicated that the data had adequate common variance and was appropriate for factor extraction.

Confirmatory Factor Analysis (CFA) was used to validate the structure derived from EFA, ensuring that the measurement model had good reliability and validity before proceeding with structural analysis. This sequential approach ensures methodological rigor by combining both EFA and CFA stages of analysis. **Table 3** presents the EFA results for latent variables.

Table 3. EFA results for latent variables.

Latent variable	Observed variable	α value	Item-total correlations	Inter-item correlations	KMO	Bartlett's test	Total variance explained	Commonalities	Loadings
	B1.1		0.477					0.352	0.549
	B1.2		0.580					0.569	0.727
	B1.3		0.657					0.606	0.684
VN_ARRE	B1.4	0.858	0.713	0.439				0.608	0.719
	B1.5		0.685					0.719	0.237
	B1.6		0.598					0.575	0.702
	B1.7		0.598					0.623	0.444
	B1.8		0.555					0.533	0.036
	B2.1		0.468					0.630	0.231
VN_MR	B2.2	0.804	0.800	0.577				0.867	0.878
	B2.3		0.718					0.829	0.844
	B3.1		0.641					0.558	0.897
	B3.2		0.754					0.688	0.890
	B3.3		0.777					0.751	0.844
VN_R	B3.4	0.903	0.762	0.578	0.828	0.000	63.698	0.738	0.833
	B3.5		0.721					0.697	0.756
	B3.6		0.767					0.710	0.625
	B3.7		0.610					0.611	0.175
	B4.1		0.744					0.733	0.849
	B4.2		0.721					0.713	0.820
VN_FI	B4.3	0.856	0.733	0.546				0.743	0.869
	B4.4		0.656					0.624	0.802
	B4.5		0.519					0.495	0.194
	B5.1		0.672					0.667	0.678
	B5.2		0.658					0.655	0.236
VN_GCR	B5.3	0.829	0.608	0.493				0.624	0.200
	B5.4		0.565					0.732	0.475
	B5.5		0.630					0.791	0.490

	B8.1		0.538					0.510	0.635
	B8.2		0.540					0.531	0.699
VN_PQ	B8.3	0.730	0.464	0.351				0.477	0.660
	B8.4		0.508					0.519	0.602
	B8.5		0.403					0.541	0.181
	C1.1		0.704					0.655	0.809
	C1.2		0.753					0.739	0.860
GSCM practices	C1.3	0.875	0.772	0.594	0.829	0.000	67.924	0.765	0.874
	C1.4		0.572					0.481	0.694
	C1.5		0.765					0.756	0.869
	D1.1		0.461					0.468	0.578
OP	D1.2	0.953	0.500	0.334				0.609	0.761
	D1.3		0.397					0.488	0.713
	D1.4		0.438					0.498	0.561
	D2.1		0.515					0.579	0.772
EP	D2.2	0.700	0.526	0.373	0.765	0.000	53.197	0.456	0.150
	D2.3		0.420					0.495	0.020
	D2.4		0.420					0.627	0.831
	D3.1		0.368					0.612	0.183
SP	D3.2	0.617	0.356	0.300				0.436	0.640
	D3.3		0.528					0.642	0.802
	D3.4		0.370					0.473	0.685

Source: Author (2024).

In **Table 3**, the total variance explained by the extracted components in each construct was above the recommended 50% threshold, suggesting that the factors identified captured a substantial portion of the variance within the data. Six components extracted for VNs explained 63.70% of the variance, GSCM practices explained 67.92%, and the combined constructs of OP, EP, and SP explained 53.20%. These findings indicate that the components identified in each construct represented meaningful dimensions that collectively accounted for a significant portion of the variability observed in the dataset.

In **Table 3**, communalities, representing the proportion of item variance explained by the common factors, ranged between 0.352 and 0.791 across all variables, with most exceeding the 0.50 threshold. These results demonstrate that a substantial portion of the variance for each item was shared with the extracted components which support the reliability of the factors.

In **Table 3**, component extraction revealed distinct factors for each construct, with value networks (VNs) comprising six components, namely relationships, actors, information flow, governance, product quality, and market responses. For GSCM practices, a single component was extracted which highlights the underlying dimensions of the construct. For performance indicators, three components were identified: operational, environmental, and social performance, each effectively capturing the respective domains within the data.

In **Table 3**, item loadings loaded strongly onto their respective factors, with loadings ranging from 0.036 to 0.897. While some items, such as B1.5 and B1.8, showed lower loadings, their theoretical relevance to VN_ARRE justified their inclusion in the final model. In **Table 3**, cross-loadings of items across multiple components were observed. These items were evaluated using the 0.40-0.30-0.20 rule to determine whether they should be retained or excluded based on their primary and alternate factor loadings. Items that demonstrated cross-loadings but met the theoretical congruence with the construct were retained, whereas those lacking theoretical alignment were removed from further analysis. This ensured that the measuring items used accurately and meaningfully captured the intended constructs while maintaining coherence and validity throughout the research process. The next section presented the results of the SEM performed for this study.

4.3. Measurement model assessment

Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed in this study to assess the relationships between latent constructs and their manifest variables. PLS-SEM was chosen due to its suitability for complex models involving multiple constructs and indicators, particularly when the primary goal is prediction and theory development, rather than theory confirmation (Hair et al., 2021). The measurement model assessment was performed to ensure that the constructs used in the structural model were both reliable and valid (Hair et al., 2019). The indicators were modelled as reflective for each latent construct based on the theoretical assumption that the constructs, such as VNs, GSCM practices, and performance outcomes, are latent variables that manifest through observed indicators. Reflective indicators are used when changes in the underlying construct are assumed to cause changes in the associated observed variables, which is consistent with the measurement approach adopted in this study. Reliability was assessed using composite reliability (CR) and Cronbach's alpha, while convergent and discriminant validity were tested to ensure measurement accuracy. Following Hair, Hult, Ringle, and Sarstedt's (2014) guidelines, the outer model, which explains the links between manifest and latent variables, was evaluated before the structural model. **Table 4** presents a summary of the evaluation results for the measurement model.

Table 4. Summary of measurement model assessment.

Latent construct	Indicators	Indicator reliability	CR	AVE	Cronbach's alpha
VN_ARRE	VN1	0.716	0.918	0.850	0.941
	VN2	0.796			
	VN3	0.736			
	VN4	0.724			
VN_MR	VN5	0.986	0.811	0.617	0.963
	VN6	0.852			
VN_R	VN7	0.745	0.891	0.672	0.867
	VN10	0.895			
	VN11	0.895			

VN_FI	VN12	0.857	0.878	0.706	0.891
	VN13	0.870			
VN_GCR	VN14	0.900	0.933	0.875	0.952
	VN15	0.970			
VN_PQ	VN16	0.789	0.686	0.607	0.832
	VN17	0.702			
GSCM practices	GSCM1	0.888	0.686	0.746	0.872
	GSCM2	0.895			
	GSCM3	0.902			
EP	EP1	0.923	0.878	0.511	0.975
	EP2	0.911			
SP	SP1	0.936	0.606	0.522	0.884
	SP2	0.775			
OP	OP1	0.908	0.685	0.503	0.767
	OP2	0.831			

Source: Author (2024).

In **Table 4**, indicator reliability indicates the consistency and reliability of each indicator in measuring its respective latent construct. Values typically above 0.7 are considered good. **Table 4** shows high outer loadings, indicating that the indicators effectively capture the variance in their respective latent constructs. Composite reliability (CR) assesses the internal consistency of the latent construct, considering all its indicators. Values above 0.6 are generally acceptable. In **Table 4**, the CR values range between 0.606 and 0.933, which exceeds the minimum cut-off of 0.60. This suggested that all measuring items consistently measure their corresponding construct. Average variance extracted (AVE) measures the amount of variance captured by the construct relative to the measurement error. AVE values above 0.5 indicate good convergent validity. Most constructs have satisfactory AVE values above 0.5, indicating that they explain a substantial amount of variance relative to measurement error. Cronbach’s alpha assesses the internal consistency of a scale or construct, with values above 0.7 generally acceptable. Constructs exhibit good reliability, with CR values mostly above 0.6 and Cronbach’s alpha values well above 0.7, indicating high internal consistency. Next section presents the results of discriminant validity of the study.

Discriminant validity

Discriminant validity was tested using the Fornell-Larcker criterion and heterotrait-monotrait (HTMT) ratio to confirm that the constructs were distinct from one another. Generally, HTMT ratios below 0.85 are considered acceptable for discriminant validity. This method ensures that correlations between indicators of different constructs are lower than those within the same construct. This validates the distinctiveness of each variable in the model. **Table 5** presents the results of discriminant validity using the HTMT criterion.

Table 5. Heterotrait-monotrait ratio.

	VN_MR	VN_ARRE	VN_R	VN_FI	VN_GCR	VN_RQ	GP	EP	SP	OP
VN_MR										
VN_ARRE	0.033									
VN_R	0.118	0.100								
VN_FI	0.021	0.311	0.141							
VN_GCR	0.235	0.094	0.257	0.167						
VN_RQ	0.313	0.767	0.178	0.380	0.003					
GSCM practices	0.509	0.182	0.134	0.021	0.004	0.049				
EP	0.001	0.146	0.092	0.429	0.261	0.054	0.048			
SP	0.495	0.802	0.182	0.274	0.090	0.519	0.365	0.063		
OP	0.000	0.327	0.003	0.469	0.493	0.101	0.025	0.544	0.231	

Source: Author (2024).

The HTMT values for all variables ranged from 0.000 to 0.544, as displayed in **Table 5**, confirming distinctiveness well below the threshold of 0.85. This indicates no discernible issues with discriminant validity in the model, affirming that each variable measures a unique concept with minimal overlap. As mentioned above, the Fornell-Larcker criterion, developed by Fornell and Larcker (1981), was used to assess discriminant validity by determining whether each latent construct is unique and distinct from others in the model. This method compares the AVE of each construct with its correlations with other constructs. Discriminant validity is confirmed when the square root of a construct's AVE is greater than its highest correlation with any other latent construct. **Table 6** presents the results of Fornell-Larcker criteria.

Table 6. Fornell-Larcker criterion.

Latent Constructs	VN_MR	VN_ARRE	VN_R	VN_FI	VN_GCR	VN_RQ	GSCM Practices	EP	SP	OP
VN_MR	0.922	0.033	0.118	0.021	0.235	0.313	0.509	0.001	0.495	0
VN_ARRE	0.033	0.786	0.1	0.311	0.094	0.767	0.182	0.146	0.802	0.327
VN_R	0.118	0.1	0.82	0.141	0.257	0.178	0.134	0.092	0.182	0.003
VN_FI	0.021	0.311	0.141	0.84	0.167	0.38	0.021	0.429	0.274	0.469
VN_GCR	0.235	0.094	0.257	0.167	0.935	0.003	0.004	0.261	0.09	0.493
VN_RQ	0.313	0.767	0.178	0.38	0.003	0.779	0.049	0.054	0.519	0.101
GSCM Practices	0.509	0.182	0.134	0.021	0.004	0.049	0.864	0.048	0.365	0.025
EP	0.001	0.146	0.092	0.429	0.261	0.054	0.048	0.715	0.063	0.544
SP	0.495	0.802	0.182	0.274	0.09	0.519	0.365	0.063	0.722	0.231
OP	0	0.327	0.003	0.469	0.493	0.101	0.025	0.544	0.231	0.71

Source: Author (2024).

The highlighted diagonal values in **Table 6** represent the square roots of the AVE for each construct, used to assess discriminant validity. Since these diagonal values are greater than the corresponding correlations with other constructs, discriminant validity has been established, indicating that each construct is sufficiently distinct from the others. The assessment of discriminant validity for the study, using both the Heterotrait-Monotrait (HTMT) ratio and the Fornell-Larcker criterion, confirmed that each construct was distinct and sufficiently unique from others. The next section presents the results of structural model assessment performed in this study.

4.4. Structural model assessment

The second step involves structural model evaluation. This analysis comprises the variance inflation factor (VIF) and tolerance, coefficient of determination (R^2), effect size (f^2), and predictive relevance (Q^2). **Table 7** provides an assessment of the structural model using several key indicators.

Table 7. Summary of multicollinearity, predictive power, effect size, and predictive relevance for latent constructs.

Latent Construct	VIF Range	R-square	Effect Size (f^2)	Predictive Relevance (Q^2)
GSCM practices	1.526–2.305	0.402	Moderate (0.3 < f2 ≤ 0.50)	0.35
EP	1.804–2.605	0.317	Moderate (0.3 < f2 ≤ 0.50)	0.26
SP	1.620–1.693	0.889	Moderate (0.3 < f2 ≤ 0.50)	0.18
OP	1.003–1.236	0.629	Moderate (0.3 < f2 ≤ 0.50)	0.34

Source: Author (2024).

In **Table 7**, VIF measures multicollinearity among predictors in regression analysis. Values below 5 generally indicate acceptable levels of multicollinearity. Results show that all values were below 5, suggesting that multicollinearity is not a significant issue for these indicators. R-squared indicates the proportion of variance in the dependent variable explained by the independent variables. Higher values denote stronger explanatory power. The structural model explains approximately 40.2% of the variance in GSCM practices, suggesting a moderate level of variability accounted for by the indicators. For EP, 31.7% of the variance is explained, indicating a moderate capturing of variability. SP shows a strong relationship, with 88.9% of the variance explained by the indicators, signifying a robust association. OP demonstrates that 62.9% of the variance is explained, indicating a substantial portion captured by the indicators. It was found that all the f^2 values ranged between 0.3 and 0.50, indicating a moderate significant effect on the validity of the model.

4.5. Model-fit statistics

Model fit indices assess how well the proposed model fits the observed data which is crucial for valid interpretations of relationships between variables. **Table 8** presents the results of model-fit statistics.

Table 8. Model-fit statistics.

Fit indices	Acceptable fit indices	Sources	Original CFA	Adjusted CFA	SEM
GFI	> 0.90	Afthanorhan (2013)	0.65	0.986	0.931
NFI	> 0.90	Hair et al. (2010)	0.61	0.907	0.913
SRMR	0.08–0.10	Hair et al. (2010)	0.136	0.043	0.045

Note: CFA, confirmatory factor analysis; SEM, structural equation modelling.
Source: Author (2024)

In **Table 8**, model fit was assessed using Goodness of Fit (GFI), Normed Fit Index (NFI), and Standardized Root Mean Square Residual (SRMR). The GFI improved from 0.65 in the original CFA to 0.986 in the adjusted CFA and 0.931 in SEM, surpassing the 0.90 threshold (Afthanorhan, 2013). The NFI also improved to acceptable levels (> 0.90) in both the adjusted CFA (0.907) and SEM (0.913) (Hair et al., 2010). SRMR values fell within the acceptable range (0.043 for adjusted CFA and 0.045 for structural equation modelling (SEM). These improvements indicate that the adjusted model provides a significantly better fit than the original CFA, supporting its suitability in representing the relationships among the variables.

The structural equation model presented evaluates the relationships between value networks (VNs), green supply chain management practices (GSCMP), and various performance outcomes, including environmental performance (EP), social performance (SP), and operational performance (OP). VNs serve as a foundational element, significantly influencing GSCMP with a path coefficient of 0.611, indicating that robust VNs enhance the adoption of green practices. These practices, in turn, positively impact EP (0.317), SP (0.889), and OP (0.402), highlighting their crucial mediating role. The model also shows that VNs have direct positive effects on EP (0.574), SP (0.225), and OP (0.517), suggesting that enhancing VNs can directly and indirectly benefit multiple facets of sustainability. GSCM practices have a very strong effect on SP, implying substantial community or stakeholder engagement benefits. The indicator reliability values (generally above 0.7) further indicate that the constructs are well-represented by their respective measures. The model underlined the importance of VNs in fostering green practices, which subsequently improve environmental, social, and operational outcomes. **Figure 2** displays the results of the direct path analysis.

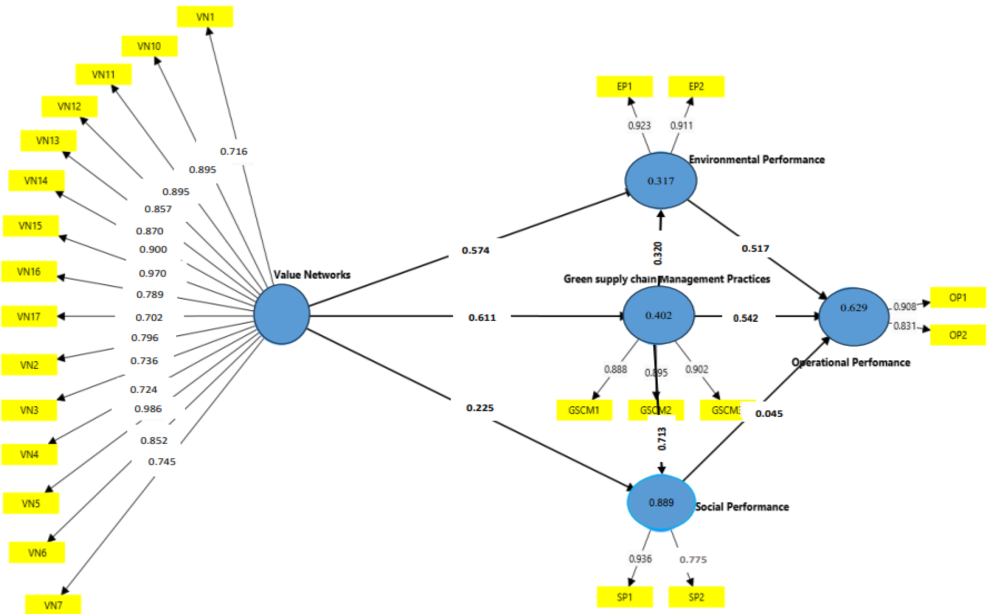

Figure 2. Significant and non-significant relationships in the study model.

Note: VNs, value networks, GSCM practices, green supply chain management practices; OP, operational performance, EP, environmental performance, SP, social performance.
* Significant at $p < 0.001$.
*Significant at $t > 1.96$.
Source: Author (2024).

4.6. Hypothesis testing

The study employed SEM to test the proposed structural correlations. According to Wong (2013), a standardised path coefficient should be more than 0.20 to be considered significant in the mode. The significance of path coefficients was confirmed using a bootstrap approach with 5000 samples, where coefficients with *t*-values exceeding 1.96 at the 95% confidence level were deemed significant. This approach aligns with Hair et al. (2014), who recommended reporting t-statistics and *p*-values from bootstrapping procedures to assess path significance accurately. Using a standardised path coefficient threshold of 0.20 as a cut-off value for significance is a common practice in many fields of research. **Table 6** presents the results of the path coefficient which were assessed at a 95% confidence interval. **Table 9** presents the results direct path analysis.

Table 9. Results of direct path analysis.

Paths	**Hypothesis**	**Path coefficient (β value)**	***t* Values**	***P* Values**	**Decision**
GSCM practices⟵VNs	H1	0.611	3.284	0.000	Supported
EP⟵VNs	H2	0.574	2.095	0.000	Supported
EP⟵GSCM practices	H3	0.320	2.240	0.000	Supported
SP⟵GSCM practices	H4	0.713	3.332	0.000	Supported
SP⟵VNs	H5	0.225	3.009	0.000	Supported
OP⟵GSCM practices	H8	0.542	2.809	0.000	Supported
OP⟵EP	H9	0.517	2.601	0.000	Supported
OP⟵SP	H10	0.045	1.694	0.576	Not Supported

Source: Author (2024)
VNs, value networks, GSCM practices, green chain management practices; OP, operational performance, EP, environmental performance, SP, social performance.
* Significant at $p < 0.001$.
* Significant at $T > 1.96$.

In **Table 9**, key findings from the analysis indicate several significant relationships between value networks (VNs), green supply chain management (GSCM) practices, and the performance dimensions of environmental (EP), social (SP), and operational performance (OP). VNs were found to positively influence GSCM practices (β = 0.611, t = 3.284, p < 0.001), suggesting that collaborations and partnerships significantly enhance the adoption of sustainable practices among smallholder paprika farmers. VNs also demonstrated a positive effect on both EP (β = 0.574, t = 2.095, p < 0.001) and SP (β = 0.225, t = 3.009, p < 0.001). This suggests that stronger VNs contribute to better environmental outcomes, such as reduced energy consumption and solid waste. The findings further reveal that GSCM practices have significant positive effects on EP (β = 0.320, t = 2.240, p < 0.001) and SP (β = 0.713, t = 3.332, p < 0.001), indicating that sustainable SC practices not only enhance EP but also generate social benefits. GSCM practices were also found to have a positive impact on OP (β = 0.542, t = 2.809, p < 0.001), suggesting that sustainable practices contribute to enhanced OP, possibly through improved efficiency and cost savings. EP was also found to positively influence OP (β = 0.517, t = 2.601, p < 0.001), further supporting the argument that environmentally friendly practices can lead to better overall performance outcomes, such as increased yields and product quality. However, the relationship between SP and OP was found to be statistically insignificant (β = 0.045, t = 1.694, p = 0.576). This suggests that while there may be a positive trend between SP and operational outcomes, it is not strong enough to be considered significant in this context. Results highlight the significant relationships between VNs, GSCM practices, and performance outcome across environmental, social, and operational dimensions, with most paths being significant at the 95% confidence level (p < 0.05), except for the relationship between SP and OP. The next section presents the results of indirect path analysis of this study.

4.7. Mediation effect analysis

Mediation analysis was conducted to explore the relationships between latent variables. GSCM practices, EP, and SP acted as mediators in the model. Indirect effects were tested for hypotheses H6, H7, H11, H12, and H13 to assess the significance of mediation effects and confirm non-zero indirect effects. Results are summarised in **Table 10**.

Table 10. Results of indirect path analysis.

Paths	Hypothesis	Path coefficient	T values	P Values	Decision
EP⟵ GSCM practices⟵VNs	H6	0.196	3.191	0.001	Supported
SP⟵GSCM practices⟵VNs	H7	0.436	3.958	0.000	Supported
OP⟵ GSCM practices⟵VNs	H11	0.331	4.489	0.000	Supported
OP⟵EP⟵VNs	H12	0.297	2.683	0.000	Supported
OP⟵SP⟵VNs	H13	0.010	1.134	0.080	Not Supported

Source: Author (2024)
VNs, value networks, GSCM practices, green chain management practices; OP, operational performance, EP, environmental performance, and SP, social performance.
* Significant at p < 0.001.
* Significant at T > 1.96.

In **Table 10**, key findings from the mediation analysis indicate significant relationships between value networks (VNs), green supply chain management (GSCM) practices, and various dimensions of performance, namely operational, environmental, and social. GSCM practices were found to act as a significant mediator between VNs and performance outcomes. The indirect effect of VNs on EP through GSCM practices was significant, demonstrating that GSCM practices positively mediate this relationship. GSCM practices significantly mediate the relationship between VNs and SP, indicating an enhanced social impact when VNs are supported by sustainable practices. OP also showed a significant positive effect when mediated by GSCM practices. EP was found to significantly mediate the relationship between VNs and OP, suggesting that improving EP can lead to better operational outcomes when VNs are effectively utilised. However, the indirect effect of VNs on OP through SP was not supported, implying that SP does not significantly mediate operational outcomes in this context. The discussion of this research is provided below.

5. Discussion

The first objective was to examine the extent to which value networks (VNs) were being implemented in smallholder paprika farming in Zimbabwe. The findings indicate that smallholder paprika farmers have benefited from support networks involving input suppliers, donors, and mobile service providers. This reflects a significant level of connectivity within the VNs, which is consistent with the theoretical perspective of Lusch and Nambisan (2015). This connectivity helps facilitate resource exchange, knowledge transfer, and support that are essential for the survival and growth of smallholder farmers. The presence of donors and mobile service providers indicates an effort to incorporate technologies and support mechanisms into these traditional farming networks. The results showed a high level of market responsiveness and quality control, with smallholder farmers adjusting to customer preferences and producing high-quality paprika. This demonstrates that VNs are enabling smallholder farmers to improve their competitive position by meeting market demands. The high level of market responsiveness and quality control observed among smallholder paprika farmers aligns with previous research on adaptive agricultural practices. Challinor et al. (2018) noted that smallholder farmers in sub-Saharan Africa are increasingly adapting their production strategies to meet changing consumer preferences and market demands. Market orientation, especially in export-driven crops, led to improved quality control and customer satisfaction through product differentiation. Reardon et al. (2021) highlight that modern value chains improve market responsiveness by integrating farmers into systems where they receive feedback and support on quality control, which significantly enhances product quality and customer satisfaction.

Results indicate that smallholder farmers are accessing diverse resources, including funding, technical advice, and market information. This demonstrates that VNs can play a critical role in enabling farmers to obtain inputs they would otherwise lack. Fanzo et al. (2020) aligned with these findings, as they discussed how smallholder farmers benefit from timely information and support provided through networks which improve their production quality and market responsiveness. Barrett et al. (2019) highlighted the role of networks in facilitating smallholder farmers' access to financial and technical resources, which are essential for overcoming barriers related to market access and production efficiency. Devaux et al. (2016) found that networks can mitigate risks for smallholder farmers by providing better access to market information, thus reducing uncertainties in pricing and demand. Results indicate challenges in maintaining effective long-term relationships. Farmers had short-term relationships with intermediaries, input suppliers, and banks, which reflects instability in stakeholder collaborations. This finding contradicts the argument by Hakanson and Johanson (1992) and Ding et al. (2023) that stable, long-term relationships are essential for efficient value co-creation. The lack of long-term relationships suggests that these VNs are not fully optimised to deliver sustainable benefits over time. One major finding was the strong influence of intermediaries in determining prices and controlling access to high-value markets. This suggests an imbalance of power within the VNs, where intermediaries have more influence compared to the farmers. Such an imbalance hinders the full potential of VNs, as smallholder farmers lack the bargaining power necessary to negotiate better prices. This outcome is consistent with the findings of Jengka (2020), who noted that power asymmetries between farmers and intermediaries often limit the benefits that farmers can derive from value chains. Bai et al. (2022) found that intermediaries dictate terms that disadvantage smallholder farmers. Farmers frequently lacked market intelligence and logistical resources to negotiate better prices, resulting in dependence on intermediaries. Xu et al. (2023) noted that digital platforms could disrupt the traditional power dynamics in agricultural value chains by providing smallholder farmers with direct access to market information and buyers, thereby reducing their reliance on intermediaries.

Results show that governance structures within the value networks (VNs) posed challenges, such as high taxes on imported seeds and restricted access to high-value markets. The presence of high taxes on imported seeds and lengthy testing processes for foreign seeds also creates barriers to accessing high-quality inputs, which are crucial for improving productivity and product quality. Parsons et al. (2021) explored the impact of lengthy approval and testing processes for foreign seeds in developing countries. Their study showed that these regulatory barriers delay the introduction of new and improved seed varieties, limiting the farmers' ability to respond to changing market demands and reduce the risks associated with climate variability. Jayne and Traub (2021) found that restrictive policies on input imports, particularly seeds, have long-term negative effects on agricultural productivity. While there was evidence of strong information flow, there were also indications of information asymmetry, as intermediaries were found to withhold relevant market information. This is problematic as it prevents smallholder farmers from making informed decisions about market participation and pricing. It suggests that although VN offers some degree of information exchange, it is not fully transparent, and there are significant gaps in the flow of critical information between stakeholders. Abebe and Alemayehu (2021) found that the lack of transparency in the flow of market information disproportionately affects smallholder farmers in Africa, as they depend heavily on intermediaries for accessing high-value markets. Choudhary et al. (2023) emphasised that information asymmetry is a significant barrier to efficient market participation for smallholder farmers.

The second objective was to establish the level of implementation of green supply chain management (GSCM) practices in smallholder paprika farming in Zimbabwe. Results indicated that GSCM practices, such as environmentally friendly packaging, renewable energy sources, and recyclable raw materials, were widely adopted by farmers. These findings align with research by Govindan et al. (2014), who emphasised that the adoption of GSCM practices in agricultural supply chains is increasingly driven by regulatory pressure and market demand for sustainability. Similarly, Agyabeng-Mensah et al. (2020) highlighted those sustainable practices, especially in developing countries, which are often implemented as part of broader environmental management strategies. Okafor et al. (2022) found that the use of renewable energy sources, such as solar power, is becoming more common among smallholder farmers in sub-Saharan Africa, particularly as part of efforts to reduce greenhouse gas emissions and lower energy costs. Oztuna Taner (2024b) highlights the adoption of energy-efficient technology that reduces greenhouse gas emissions.

This aligns with the goal of reducing the ecological footprint of smallholder farmers, who often struggle to meet international sustainability standards. Taner and Çolak (2024) indicate that the adoption of AI to model production processes can increase energy efficiency in dairy factories, highlighting how technology can streamline resource use.

Taner et al. (2024) focus on reducing energy consumption through AI-driven heat exchanger predictions aligned with the SVN emphasis on GSCM. By cutting down on energy use, AI applications in food processing reduce environmental impact, a core priority within SVNs that aim to achieve economic and ecological sustainability. While the adoption of these practices signals a positive shift toward more sustainable farming, further research is needed to evaluate whether these practices have led to tangible improvements in supply chain efficiency.

The third objective was to determine how value networks (VNs) influence environmental and social performance through GSCM practices. The findings revealed that VNs had significant positive effects on both EP and SP, which were mediated by GSCM practices. The indirect effect of VNs on EP through GSCM practices suggests that VNs, supported by sustainable supply chain practices, enhance EP. This is in line with the studies by Castañer and Oliveira (2020), which suggest that VNs create the foundation for adopting sustainable practices, leading to reduced waste and improved resource efficiency. The significant positive mediation effect of VNs on SP via GSCM practices aligns with the findings of Khaskhelly et al. (2023), emphasising that VNs contribute to community well-being by providing access to resources, training, and fair market opportunities. In Zimbabwe, sustainable practices are essential for improving both operational and environmental performance. Similarly, Taner (2024) highlights how short supply chains contribute to environmental sustainability and social support in the Western Balkans. This finding supports the notion that the integration of sustainable practices into VNs can enhance SP, such as improved living conditions, better healthcare, and increased income for smallholder farmers. However, the relationship between VNs and SP was not as strong as anticipated, particularly in terms of OP. This finding was unexpected, given the positive relationship between GSCM practices and SP. It implies that while sustainable practices may lead to better SP, these improvements may not always translate into enhanced operational efficiency for smallholder paprika farmers.

The fourth objective was to analyse how green supply chain management (GSCM) practices, environmental performance (EP), and social performance (SP) influence the interaction between value networks (VNs) and operational performance (OP) in smallholder paprika farming. The results showed that GSCM practices significantly influenced OP, supporting the view of Laosirihongthong et al. (2013) that GSCM practices lead to improved operational metrics, such as product quality, delivery reliability, and flexibility. Geng et al. (2022) found that the integration of GSCM practices, such as environmentally friendly packaging and the use of renewable energy sources, positively impacts OP by improving resource efficiency and reducing operational costs. The adoption of sustainable practices led to improved agility, cost efficiency, and reliability which enhance the competitiveness of smallholder farmers in Zimbabwe.

Results indicate that environmental performance (EP) showed a significant positive effect on operational performance (OP), highlighting those improvements in environmental practices, such as energy consumption and waste reduction, contribute to better operational efficiency, such as increased productivity and profitability. This result is consistent with the findings of Wu et al. (2011) and Samad et al. (2021), which suggested that enhancing EP through GSCM practices could lead to improved efficiency in supply chain activities. In contrast, the relationship between SP and OP was not statistically significant, indicating that SP may not directly influence operational outcomes. This finding was unexpected and contradicts the work of Awan et al. (2018) and Rubio-Andrés et al. (2022), who suggested that positive SP, such as improved worker productivity and community well-being, could lead to enhanced operational efficiency. The insignificant effect of SP on OP suggests that the social benefits gained from improved income, reduced hunger, and better access to commodities do not necessarily translate into better OP for smallholder farmers.

The results of the mediation analysis provided further insights into the relationships between value networks (VNs), green supply chain management (GSCM) practices, and various performance metrics. GSCM practices were found to mediate the relationship between VNs and EP, SP, and OP, suggesting that the adoption of sustainable practices can amplify the positive effects of VNs. This finding is consistent with the work of Chavez et al. (2022), who highlighted the importance of GSCM practices in transforming VNs to improve operational, environmental, and social outcomes. Azevedo et al. (2022) explored how GSCM practices mediate the relationship between value chains and overall supply chain performance. Their research demonstrated that sustainable practices, such as eco-friendly packaging, renewable energy use, and resource optimisation, significantly contribute to both operational and environmental performance. However, SP did not significantly mediate the relationship between VNs and OP, suggesting that the social benefits derived from sustainable practices may not directly influence operational efficiency in the context of smallholder paprika farming. This result emphasises the need for further investigation into the mechanisms through which SP affect OP and suggests that other factors, such as market dynamics or resource availability, may play a more significant role in determining operational outcomes.

6. Conclusion

This study investigates the impact of sustainable value networks (SVNs) on the operational, environmental, and social performance of smallholder paprika farmers in Zimbabwe, particularly emphasising the role of green supply chain management (GSCM) practices. The study found moderate implementation of value networks (VNs) in smallholder paprika farming in Zimbabwe, driven by resource sharing, financial inclusion via VSLAs, and support from input suppliers and extension workers. However, limited market access, transport issues, financial constraints, and regulatory challenges hinder full implementation. There was a higher-than-expected adoption of green supply chain management (GSCM) practices, including eco-friendly packaging and green procurement, driven by Environmental Management Agency (EMA) regulations and international market standards compliance. The key findings indicate that the integration of GSCM practices within VNs significantly enhances EP and OP while contributing to social well-being. The SVN model proposed in this study offers a comprehensive approach to improving the sustainability and productivity of smallholder farming by focusing on network collaboration, resource exchange, and sustainable practices. The results demonstrate that GSCM practices significantly mediate the relationship between VNs and various performance outcomes. GSCM practices enhance both EP and OP, suggesting that the adoption of sustainable practices such as eco-friendly packaging, renewable energy, and waste management can lead to substantial improvements in productivity and market access for smallholder farmers. The findings reveal that well-established VNs positively influence the adoption of GSCM practices, thereby improving EP and SP. This emphasises the importance of strong, collaborative relationships among stakeholders, including donors, input suppliers, and extension services, in fostering sustainable practices among farmers. The study found that, while SP contributes to community well-being, its direct effect on OP is statistically insignificant. This suggests that although improving social conditions is important, additional factors may be required to directly influence operational efficiency. A significant relationship was found between EP and OP, indicating that better environmental practices (e.g., reduced waste, energy efficiency) can lead to improved productivity and profitability. This finding underlines the importance of environmental sustainability as a driver of supply chain efficiency in smallholder farming. The next section provides the practical implications of this study.

7. Practical contributions and implications for stakeholders

Governments should facilitate the creation and strengthening of value networks (VNs) by supporting village savings and loan associations (VSLAs) and by providing subsidies for environmentally friendly inputs. Such initiatives can reduce farmers' financial constraints and enhance their access to quality inputs, thus improving productivity and sustainability. The findings indicate that high taxes on imported seeds and regulatory barriers limit access to high-quality inputs. Governments in developing economies can revise tax policies and regulatory frameworks to reduce these barriers, thus enabling smallholder farmers to access and utilise resources effectively for better yields and sustainability. By adopting GSCM practices, such as green packaging and renewable energy, smallholder farmers can enhance their market competitiveness and gain access to international markets that increasingly demand sustainable products. Training programs and workshops involving NGOs, public extension workers, and agricultural experts can help smallholder farmers understand the importance of eco-friendly practices and how to implement them effectively. Taner (2024) discusses the importance of policy support in promoting smallholder access to short supply chains through advisory services and capacity building. Smallholder farmers are encouraged to leverage local networks (e.g., donor support, peer-to-peer networks, research institutes) to access necessary input and technical knowledge. This can help reduce their dependence on intermediaries and strengthen their bargaining power, thereby improving their ability to negotiate fair prices for their produce. Engaging mobile service providers to disseminate agricultural information (e.g., weather forecasts, market prices, GSCM practices) can further empower smallholder farmers. Governments or NGOs could incentivise mobile service providers to offer such services in rural farming areas at subsidised rates, enhancing farmers' access to timely and relevant information. Financial institutions can create targeted microfinance products that support the adoption of GSCM practices. These products could include low-interest loans specifically for renewable energy installations or grants to support sustainable farming inputs. Such products would help bridge the financial gap that prevents many smallholder farmers from implementing sustainable practices. NGOs can contribute by facilitating capacity-building programs that focus on both technical skills (e.g., GSCM practices) and financial literacy. This will empower farmers to better manage resources, understand their cost structures, and participate more effectively in SVNs. International buyers interested in sustainable produce could offer financial or technical assistance to help smallholder farmers obtain necessary certifications, thereby enhancing their access to high-value export markets. These certifications assure buyers of adherence to sustainability standards and help farmers obtain premium prices for their produce. The findings have implications for smallholder supply chain management, particularly in adopting SVNs and GSCM practices. These approaches help reduce dependence on intermediaries, improve market access, and boost efficiency. Smallholder farmers in other agricultural sectors, like maize or horticulture, face similar challenges. Applying the same principles of VNs and GSCM can improve their OP, sustainability, and access to high-value markets. Thus, the findings offer practical strategies that can be adapted to various crops and regions. The next section provides the theoretical contribution of this study to the field of logistics management.

8. Theoretical contributions

The study provides an integrated sustainable value network (SVN) model that incorporates green supply chain management (GSCM) practices into value networks (VNs), which addresses a notable gap in existing supply chain management (SCM) literature. While previous studies have separately explored VNs and GSCM practices, this research advances knowledge by demonstrating how the integration of these two concepts can enhance environmental, social, and operational performance. This offers a holistic perspective on the supply chain, emphasising sustainability at multiple levels of operation, which is particularly relevant for smallholder farming. By establishing the mediating role of GSCM practices between VNs and operational/environmental performance, the study makes a theoretical contribution to understanding the mechanisms through which network structures can influence supply chain sustainability outcomes. This highlights the need for SCM frameworks that focus not only on efficiency but also on sustainability, a relatively less explored domain in SCM literature. The research extends network theory by examining how VNs operate in resource-constrained environments like smallholder farming in Zimbabwe. It challenges the traditional view that central actors always play the most critical role in network success by showing how distributed networks such as VSLAs can create more resilient and equitable outcomes. This has implications for how network theory is applied in contexts where power imbalances exist and where resources are limited.

Network theory traditionally emphasises efficiency and competitiveness through collaboration. This study extends the theory by demonstrating how collaborative sustainability practices within networks can significantly influence environmental and social outcomes. It provides a model that emphasises trust-based relationships and resource sharing, particularly in developing economies, to achieve not only competitive but also sustainable supply chain advantages. The research makes an important contribution to agricultural sustainability by proposing the SVN model tailored for smallholder paprika farmers. This model demonstrates how integrating GSCM practices with existing agricultural networks can lead to improved OP, reduced environmental impact, and enhanced social well-being. The study, therefore, contributes to understanding how smallholder farmers can be integrated into sustainable global value chains (GVCs) while overcoming the barriers posed by limited access to markets and financial resources. The study operationalises the concept of sustainability in the context of agricultural supply chains by defining measurable indicators for GSCM practices, OP, EP, and SP. This framework provides a replicable model that can be applied to assess sustainability outcomes in other agricultural sectors, adding a practical dimension to sustainability research. The next section presents the limitations of the study and agenda for future research.

9. Limitations and future research

This study focused exclusively on paprika VNs among smallholder farmers in Zimbabwe, which limits the generalisability of its findings. The data was extracted from smallholder farmers. However, paprika VNs comprises of many stakeholders including input suppliers, commercial banks and public extension workers. Thus, future research could broaden the scope by including a more diverse range of stakeholders, such as local communities, policymakers, and industry experts, to gain a comprehensive understanding of paprika VNs in Zimbabwe. The study solely employed a quantitative research approach, which may have constrained the depth of insights compared to qualitative methods like interviews. Incorporating both qualitative and quantitative approaches in future studies could provide a better understanding of the implementation levels of VNs and GSCM practices and their influences on performance among smallholder paprika farmers. The study used cross-sectional data, offering only a snapshot of the relationship dynamics within paprika VNs and GSCM practices. Future research could benefit from longitudinal data collection methods to explore trends and patterns of the implementation levels of VNs and GSCM practices over time. The study focused on limited dimensions of GSCM practices like green procurement and packaging. However, future studies could expand to include other dimensions such as green distribution and reverse logistics, which are critical for enhancing operational efficiency in smallholder paprika farming in Zimbabwe. This study highlights the influence of intermediaries and regulatory barriers on effectiveness of VNs. Future research could examine the role of government policy and institutional support in mitigating these barriers. It will be interesting to establish how policies such as subsidies, tax reforms, and certification support programs can enhance the adoption of sustainable practices among smallholder farmers. This study developed a SVN model aimed at guiding smallholder farmers in Zimbabwe to enhance OP through VNs, GSCM practices, and EP. It suggests that future research should explore the broader application of the SVN model in other industries to validate its effectiveness. Given the growing role of technology in agriculture, future research could investigate how digital platforms, mobile-based advisory services, and IoT solutions can enhance the effectiveness of SVNs. This includes an understanding of the extent to which digital technologies can improve information flow, market access, and resource efficiency within smallholder value networks.

Author contributions: Conceptualisation, CT, RL and JM; methodology, CT; software, CT; validation, CT, RL and JM; formal analysis, CT; investigation, CT; resources, CT; data curation, CT; writing—original draft preparation, CT; writing—review and editing, CT, RL and JM; visualisation, CT; supervision, RL and JM; project administration, CT; funding acquisition, RL and JM. All authors have read and agreed to the published version of the manuscript.

Acknowledgments: The authors express their deep gratitude to the Department of Transport and Supply Chain Management for granting permission to conduct this study. They also extend their sincere appreciation to the farmers who generously shared their valuable insights during the data collection process. This research was conducted without any external support.

Conflict of interest: The authors declare no conflict of interest.

References

Abbasi, S. and Erdebilli, B., 2023. Green closed-loop supply chain networks' response to various carbon policies during COVID-19. Sustainability, 15(4), p.3677.

Afthanorhan, W.M.A.B.W., 2013. A comparison of partial least square structural equation modeling (PLS-SEM) and covariance based structural equation modeling (CB-SEM) for confirmatory factor analysis. International Journal of Engineering Science and Innovative Technology, 2(5), pp.198-205.

Agyabeng-Mensah, Y., Ahenkorah, E., Afum, E. and Owusu, D., 2020. The influence of lean management and environmental practices on relative competitive quality and performance. Journal of Manufacturing Technology Management, 31(7), pp.1351-1372.

Aroonsrimorakot, S. and Laiphrakpam, M., 2024. Green Supply Chain Management (GSCM) and Circular Economy (CE): A Rapid Review of their Conceptual Relationships. Asia Social Issues, 17(3), p.e259742.

Awan, U., Kraslawski, A. and Huiskonen, J., 2018. Governing interfirm relationships for social sustainability: the relationship between governance mechanisms, sustainable collaboration, and cultural intelligence. Sustainability, 10(12), p.4473.

Bai, J., Wahl, T. I., & Zhong, F. (2022). Power imbalances in vegetable supply chains in East Asia: Challenges for smallholder farmers. Agricultural Economics, 53(3), 503-514. https://doi.org/10.1111/agec.12723.

Balasubramanian, S. and Shukla, V., 2017. Green supply chain management: an empirical investigation into the construction sector. Supply Chain Management: An International Journal, 22(1), pp.58-81.

Barrett, C. B., Christiaensen, L., Sheahan, M., & Shimeles, A. (2019). On the Structural Transformation of Rural Africa. Journal of African Economies, 28(2), 1-30. https://doi.org/10.1093/jae/ejz020.

Bourne, M., Pavlov, A., Franco-Santos, M., Lucianetti, L. and Mura, M., 2013. Generating organisational performance: The contributing effects of performance measurement and human resource management practices. International Journal of Operations & Production Management, 33(11/12), pp.1599-1622.

Castañer, X. and Oliveira, N., 2020. Collaboration, coordination, and cooperation among organizations: Establishing the distinctive meanings of these terms through a systematic literature review. Journal of Management, 46(6), pp.965-1001.

Challinor, A. J., Adger, W. N., Benton, T. G., Conway, D., Joshi, M., & Frame, D. (2018). Vulnerability of food systems to climate instability. Nature Climate Change, 8(5), 329-335. https://doi.org/10.1038/s41558-018-0152-1.

Chavez, R., Yu, W., & Feng, M. (2022). Green supply chain management practices and their impact on environmental and operational performance: A study of value networks. Journal of Supply Chain Management, 58(2), 47-62. https://doi.org/10.1111/jscm.12298.

Chavez, R., Yu, W., Jajja, M.S.S., Song, Y. and Nakara, W., 2022. The relationship between internal lean practices and sustainable performance: exploring the mediating role of social performance. Production Planning & Control, 33(11), pp.1025-1042.

Choudhary, M., Sinha, P., & Singh, R. (2023). The role of intermediaries in perpetuating information asymmetry in agricultural markets: Evidence from South Asia. Journal of Development Studies, 59(1), 55-68. https://doi.org/10.1080/00220388.2022.2111803.

Christensen, C.M. and Rosenbloom, R.S., 1995. Explaining the attacker's advantage: Technological paradigms, organizational dynamics, and the value network. Research Policy, 24(2), pp.233-257.

Das, G., Li, S., Tunio, R.A., Jamali, R.H., Ullah, I. and Fernando, K.W.T.M., 2023. The implementation of green supply chain management (GSCM) and environmental management system (EMS) practices and its impact on market competitiveness during COVID-19. Environmental Science and Pollution Research, 30(26), pp.68387-68402.

Dentoni, D., Bitzer, V., & Schuster, M., 2015. The Legume Innovation Network (LIN): Co-creating Knowledge at the Intersection of Agribusiness, Rural Development, and Research. Agricultural Systems. 138, pp. 55-64. https://doi.org/10.1016/j.agsy.2015.05.001.

Devaux, A., Torero, M., Donovan, J., & Horton, D. (2016). Innovation for inclusive value-chain development: Successes and challenges. IFPRI. https://doi.org/10.2499/9780896292130.

Ding, H., Zheng, Q., & Niu, L. 2023. Exploring green innovation adoption and value co-creation in supply chain networks. Journal of Cleaner Production, 384, 135531.

Ding, Y., Zheng, D. and Niu, X., 2023. Collaborative Green Innovation of Livestock Product Three-Level Supply Chain Traceability System: A Value Co-Creation Perspective. Sustainability, 16(1), p.297.

ECLAC, 2021. Agriculture and Rural Development in Latin America and the Caribbean. Economic Commission for Latin America and the Caribbean. Available at: https://www.cepal.org/en/publications [Accessed 6 October 2024].

E-Vahdati, S., Noor, N.A.M., Mah, P.Y., Chuah, F. and Md Isa, F., 2023. Social and environmental sustainability, workers' well-being, and affective organizational commitment in palm oil industries. Sustainability, 15(12), p.9514.

Famiyeh, S., Adaku, E., Amoako-Gyampah, K., Asante-Darko, D. and Amoatey, C.T., 2018. Environmental management practices, operational competitiveness, and environmental performance: Empirical evidence from a developing country. Journal of Manufacturing Technology Management, 29(3), pp.588-607.

Fang, C. and Zhang, J., 2018. Performance of green supply chain management: A systematic review and meta-analysis. Journal of Cleaner Production, 183, pp.1064-1081.

FAO, 2021. Zimbabwe: Country Programming Framework. Food and Agriculture Organization of the United Nations. Available at: https://www.fao.org [Accessed 6 October 2024].

FAO, 2022. The State of Food and Agriculture 2022: Leveraging Agricultural Innovations for Inclusive and Sustainable Smallholder Farming. Food and Agriculture Organization of the United Nations. Available at: https://www.fao.org/publications [Accessed 6 October 2024].

Geng, R., Mansouri, S. A., & Aktas, E. (2022). Green supply chain management practices and operational performance: The role of internal integration and external collaboration. Resources, Conservation, and Recycling, 181, 106169. https://doi.org/10.1016/j.resconrec.2022.106169.

Gimenez, C. and Tachizawa, E.M., 2012. Extending sustainability to suppliers: a systematic literature review. Supply Chain Management: An International Journal, 17(5), pp.531-543.

Golicic, S.L. and Smith, C.D., 2013. A meta-analysis of environmentally sustainable supply chain management practices and firm performance. Journal of Supply Chain Management, 49(2), pp.78-95.

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. and Tatham, R.L., 2011. Multivariate Data Analysis. 7th ed. Upper Saddle River, NJ: Pearson.

Hair, J.F., Hult, G.T.M., Ringle, C.M., & Sarstedt, M. (2021). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM) (3rd ed.). SAGE Publications.

Hair, J.F., Risher, J.J., Sarstedt, M., & Ringle, C.M. (2019). When to use and how to report the results of PLS-SEM. European Business Review, 31(1), 2-24. https://doi.org/10.1108/EBR-11-2018-0203.
Harter, J.K., Schmidt, F.L. and Hayes, T.L., 2002. Business-unit-level relationship between employee satisfaction, employee engagement, and business outcomes: a meta-analysis. Journal of Applied Psychology, 87(2), p.268.
Hill, R., Sibanda, L.M., & Marandure, T., 2021. Challenges faced by smallholder farmers in accessing formal markets: A case study of Zimbabwe. Development Southern Africa, 38(6), pp.875-890.
Hoyle, R.H. ed., 1995. Structural equation modeling: Concepts, issues, and applications. Sage.
Huq, F.A., Chowdhury, I.N. and Klassen, R.D., 2016. Social management capabilities of multinational buying firms and their emerging market suppliers: An exploratory study of the clothing industry. Journal of Operations Management, 46, pp.19-37.
IFPRI, 2020. Smallholder Farmers in Asia and Their Contributions to Sustainable Agriculture. International Food Policy Research Institute. Available at: https://www.ifpri.org/publication [Accessed 6 October 2024].
Jayne, T. S., & Traub, L. (2021). Restrictive policies and their impact on agricultural innovation in sub-Saharan Africa. World Development, 138, 105232. https://doi.org/10.1016/j.worlddev.2020.105232.
Jengka, B.T.A.R., 2020. Challenges in marketing channel selection by smallholder pineapple growers in Samarahan, Sarawak, Malaysia. Food Research, 4(5), pp.77-85.
Khan, S., & Dong, L., 2017. Green Supply Chain Management Practices and Organizational Performance: A Review and Research Agenda. International Journal of Production Economics, 183(Part B), 595-614.
Khaskhelly, F.Z., Raza, A., Azhar, H., Zehra, N.Z., Safdar, M.H. and Khokhar, M., 2023. Corporate Social Responsibility through Collaboration in the Supply Chain: Insights into a More Sustainable Economy. Reviews of Management Sciences, 5(1), pp.50-62.
Krejcie, R.V. and Morgan, D.W., 1970. Determining sample size for research activities. Educational and psychological measurement, 30(3), pp.607-610.
Kumar, N., Agrahari, R.P. and Roy, D., 2015. Review of green supply chain processes. IFAC-Papersonline, 48(3), pp.374-381.
Langyintuo, A.S., 2020. Enhancing smallholder farmer productivity in Sub-Saharan Africa. Food Policy, 92, Article 101859.
Laosirihongthong, T., Tan, K.H. and Adebanjo, D., 2013. An empirical study of green supply chain management practices amongst Thai manufacturers. International Journal of Production Economics, 146(1), pp.365-380.
Lissillour, R., Cui, Y., Guesmi, K., Chen, W. and Chen, Q., 2024. Value network and firm performance: the role of knowledge distance and environmental uncertainty. Journal of Knowledge Management, 28(1), pp.44-68.
Longoni, A. and Cagliano, R., 2018. Sustainable innovativeness and the triple bottom line: The role of organizational time perspective. Journal of Business Ethics, 151, pp.1097-1120.
Lusch, R.F. and Nambisan, S., 2015. Service innovation. MIS Quarterly, 39(1), pp.155-176.
Mallikarathna, D.H. and Silva, C.C., 2019, March. The impact of green supply chain management practices on operational performance and customer satisfaction. In Proceedings of the International Conference on Industrial Engineering and Operations Management, Bangkok, Thailand, pp. 5-7.
Mhaka, I., 2020. An assessment on the profitability of maize production among smallholder contracted farmers in Gokwe. Marondera University of Agricultural Sciences and Technology (Zimbabwe).
Muzvidziwa, V., 2021. Supply chain challenges in smallholder farming: A case study of Zimbabwe. Journal of Agribusiness in Developing and Emerging Economies, 11(3), pp.385-400.
Ngezimana, J., 2021. Value chain analysis of paprika. Case of Chimanimani District. Marondera University of Agricultural Sciences and Technology (Zimbabwe).
Njuki, J., Kruger, E. & Starr, L., 2021. Gender equality in food systems: A feminist agenda for transformative change. Journal of Gender, Agriculture and Food Security, 6(1), pp. 1-12. https://doi.org/10.1002/jgafs.2314.
Okafor, V. O., Omeh, K., & Nnamdi, C. (2022). Renewable energy adoption in sub-Saharan Africa: Insights from smallholder farmers in Nigeria. Renewable Energy, 186, 223-234. https://doi.org/10.1016/j.renene.2021.12.040.
Owusu, O., Bansah, K.J. and Mensah, A.K., 2019. "Small in size, but big in impact": Socio-environmental reforms for sustainable artisanal and small-scale mining. Journal of Sustainable Mining, 18(1), pp.38-44.
Oztuna Taner, O., 2024a. Enhancement of the energy and exergy analysis capabilities of the yoghurt process: a case study of the dairy industry. Frontiers in Sustainable Food Systems, 8, p.1450653.
Oztuna Taner, O., 2024b. Vacuum freeze dryer technology for extending the shelf life of food and protecting the environment: a scenario study of energy efficiency. Environmental Science and Pollution Research, 31(27), pp.38573-38584.

Parsons, T., de Janvry, A., & Sadoulet, E. (2021). Regulatory barriers and the slow diffusion of improved seed varieties in developing countries. Food Policy, 100, 102031. https://doi.org/10.1016/j.foodpol.2020.102031.

Piercy, N. and Rich, N., 2015. The relationship between lean operations and sustainable operations. International Journal of Operations & Production Management, 35(2), pp.282-315.

Porter, M.E. & Kramer, M.R., 2019. Creating shared value: How to reinvent capitalism—and unleash a wave of innovation and growth. Harvard Business Review, 97(1), pp. 44-57. Available at: https://hbr.org/2019/01/creating-shared-value [Accessed 6 October 2024].

Ramakrishna, Y. and Srivastava, B. eds., 2024. Strategies for Environmentally Responsible Supply Chain and Production Management. IGI Global.

Reardon, T., Echeverria, R., Berdegué, J., Minten, B., Liverpool-Tasie, S., Tschirley, D. & Zilberman, D., 2021. Rapid Transformation of Food Systems in Developing Regions: Highlighting the Role of Agricultural Research & Innovations. Agricultural Systems, 190, p. 103127.

Reinhold, J., Koldewey, C. and Dumitrescu, R., 2022. Value creation framework and roles for smart services. Procedia CIRP, 109, pp.413-418.

Ricciotti, F., 2020. From value chain to value network: a systematic literature review. Management Review Quarterly, 70(2), pp.191-212.

Rubio-Andrés, M., Ramos-González, M.D.M., Gutiérrez-Broncano, S. and Sastre-Castillo, M.Á., 2022. Creating financial and social value by improving employee well-being: a PLS-SEM application in SMEs. Mathematics, 10(23), p.4456.

Samad, S., Nilashi, M., Almulihi, A., Alrizq, M., Alghamdi, A., Mohd, S., Ahmadi, H. and Azhar, S.N.F.S., 2021. Green Supply Chain Management practices and impact on firm performance: The moderating effect of collaborative capability. Technology in Society, 67, p.101766.

Schoneveld, G.C. and Weng, X., 2023. Smallholder value creation in agrifood chains: Value network approach. Land Use Policy, 131, p.106676.

Shahid, H.M., Waseem, R., Khan, H., Waseem, F., Hasheem, M.J. and Shi, Y., 2020. Process innovation as a moderator linking sustainable supply chain management with sustainable performance in the manufacturing sector of Pakistan. Sustainability, 12(6), p.2303.

Sony, M., Antony, J. and Naik, S., 2020. How do organizations implement an effective LSS initiative? A qualitative study. Benchmarking: An International Journal, 27(5), pp.1657-1681.

Srivastava, S.K., 2007. Green supply-chain management: a state-of-the-art literature review. International Journal of Management Reviews, 9(1), pp.53-80.

Taner, Ö. Ö., 2023. Energy and production analysis of a dairy milk factory: A case of study. Journal of Thermal Engineering, 9(5), pp.1163-1176.

Taner, O.O., 2024. Sustainable Food and Agriculture Production: Reducing Food Waste through Technological Advancements and Assessing its Economic Impact. Research on World Agricultural Economy, pp.144-165.

Taner, O.O., Mercan, H., Çolak, A.B., Radulovic, J., Taner, T. and Dalkılıç, A.S., 2024. Application of artificial intelligence techniques for heat exchange predictions in food industry. In Advanced Materials-Based Thermally Enhanced Phase Change Materials (pp. 269-325). Elsevier.

Tangpong, C., Hung, K.T. and Li, J., 2019. Toward an agent-system contingency theory for behavioral supply chain and industrial marketing research. Industrial Marketing Management, 83, pp.134-147.

Tombe, R. and Smuts, H., 2023. Agricultural Social Networks: An Agricultural Value Chain-Based Digitalization Framework for an Inclusive Digital Economy. Applied Sciences, 13(11), p.6382.

Toussaint, M., Cabanelas, P. and Muñoz-Dueñas, P., 2022. Social sustainability in the food value chain: what is and how to adopt an integrative approach? Quality & Quantity, pp.1-24.

Van der Slikke, T., Dentoni, D. and Trienekens, J.H., 2017. The Relationship among Farmers' Embeddedness in Value Networks and their Innovation.

Wang, C. and Hu, Q., 2020. Knowledge sharing in supply chain networks: Effects of collaborative innovation activities and capability on innovation performance. Technovation, 94, p.102010.

Wong, C.Y. and Chin, K.S., 2019. Sustainable supply chain management: A new perspective on value creation. Sustainability Accounting, Management and Policy Journal, 10(5), pp.780-803.

World Bank, 2021. World Development Report 2021: Agriculture for Development. The World Bank. Available at: https://www.worldbank.org/en/publication/wdr2022 [Accessed 6 October 2024].

Wu, G., Dunn, S.C., Jabbour, C.J.C., Evans, S. and Ma, Z., 2011. An empirical study of green supply chain management practices amongst Chinese manufacturers. Journal of Manufacturing Technology Management, 22(7), pp.890-912.

Xu, L., Huo, B., & Zhao, X., 2022. Green supply chain management practices and organizational performance: The mediating role of environmental management capability. Resources, Conservation & Recycling, 181, Article 106069.

Younis, H., Sundarakani, B. and Vel, P., 2016. The impact of implementing green supply chain management practices on corporate performance. Competitiveness Review, 26(3), pp.216-245.

Yu, W., Chavez, R., Feng, M. and Wiengarten, F., 2014. Integrated green supply chain management and operational performance. Supply Chain Management: An International Journal, 19(5/6), pp.683-696.

Zhu, Q. and Geng, Y., 2013. Drivers and barriers of extended supply chain practices for energy saving and emission reduction among Chinese manufacturers. Journal of Cleaner Production, 40, pp.6-12.

Zhu, Q. and Sarkis, J., 2004. Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. Journal of Operations Management, 22(3), pp.265-289.

Zhu, Q., Johnson, S. and Sarkis, J., 2018, January. Lean six sigma and environmental sustainability: a hospital perspective. In Supply Chain Forum: An International Journal, 19(1), pp.25-41. Taylor & Francis.

ZIMSTAT, 2021. Zimbabwe National Agricultural Survey Report. Zimbabwe National Statistics Agency. Available at: https://www.zimstat.co.zw [Accessed 6 October 2024].

ZimTrade, 2022. Export Performance Report.