ENVIRONMENTAL SUSTAINABILITY IN KENYAN TEXTILE SUPPLY CHAINS: EVALUATING THE CONTRIBUTION OF GREEN LOGISTICS

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Abstract: Supply chains are crucial components of national economies, influencing diverse functions like operations, product development, marketing, distribution, and customer service. Despite their significant contributions, supply chains, particularly in the textile industry are implicated in environmental degradation through spinning, dyeing, manufacturing, packaging, and disposal. Addressing this concern, the growing practice of green logistics within supply chain management is gaining traction. This article investigates the impact of green logistics on environmental sustainability in the textile supply chain, grounded in the Theory of an Inclusive Green Economy. Using an observational cross-sectional design and focusing on 265 staff members from textile firms in Nairobi City County engaged in supply chain functions, it assesses the retrospective influence of green procurement, production, warehousing, and transportation on environmental sustainability. Employing Partial Least Squares Structural Equation Modelling (PLS-SEM), the results show that green procurement, production, and transportation significantly and positively predict environmental sustainability. The study highlights the textile supply chain's pivotal role in addressing the threat of the sixth mass extinction. The findings imply that aligning with the government's green economy strategy through policy guidelines, standards, and enforcement of green logistics practices is crucial for the Kenyan textile industry's environmental sustainability.

Keywords: Environmental impact, green procurement, green production, green transportation, mitigating threats, sustainable operations.

Introduction

The global supply chain has become a cornerstone for investment, production, and trade within national economies, leading to social and economic development and employment opportunities (Abbasi, 2017). This economic transformation is particularly evident in developing nations, where reliable supply chains are linked to increased productivity and overall socioeconomic growth (Goel *et al*., 2021). Among the various supply chains of global significance, the textile supply chain stands out, playing a critical role in the economic growth of many nations, contributing to high employment levels, foreign exchange revenue, and human welfare (Yaghin & Darvishi, 2020).

Notably, Mauritius leads the way with a 32% contribution of textiles to total manufacturing, followed by other nations such as Alabama, Macao, Eritrea, Moldova, Hong Kong, Vietnam, Mongolia, Bulgaria, and Romania, each relying significantly on textiles for their economic sustenance (Syrowik, 2017). Even though Kenya does not feature in the top 10 nations, its Cotton, Textiles, and Apparel (CTA) industry is the second-largest manufacturing sector after food processing, underscoring the sector's importance (Malicha & Njoroge, 2020).

Despite the undeniable economic importance of the textile supply chain, its environmental sustainability is a growing concern. Research indicates that the sheer volume of textiles being produced and consumed leads to extensive waste generation and improper disposal, causing environmental damage and negatively impacting

the health of supply chain stakeholders (Yalcin-Enis *et al*., 2019). Processes such as manufacturing, spinning, dying, packaging, and disposal within the textile supply chain contribute to environmental harm (Panigrahi & Santhoskumar, 2020).

In the current era of heightened focus on sustainability, transitioning to circular models becomes imperative for the textile industry, especially in the Kenyan context. A potential solution lies in embracing green logistics across all levels of the textile supply chain. Green logistics, aimed at reducing the environmental impact of supply chain logistics is gaining traction as a practice capable of mitigating environmental concerns associated with supply chains (Teixeira *et al*., 2018). Larina (2021) emphasises that green logistics involves modern transportation technologies, targeting sustainable development across the environment, economy, and society.

The Inclusive Green Economy (IGE) theory posits that green logistics components, including procurement, production, warehousing, and transportation can address persistent poverty, planetary boundaries, and inequitable growth challenges (Gu *et al*., 2021). Research supports the idea that green logistics is necessary for environmental sustainability and a key driver of profitability and overcoming trade barriers, particularly in developing nations (Ashfaq *et al*., 2020; Karaman *et al*., 2020).

Empirical evidence from various contexts, including Polish Small and Medium-sized Enterprises (SMEs), Lithuanian logistics companies, Asian manufacturing firms, and Greek agri-food supply chains consistently highlights the positive impact of green logistics on environmental and social sustainability (Zowada, 2020; Trivellas *et al*., 2020; Vienazindiene *et al*., 2021). Additionally, the textile industry's significant contribution to pollution, accounting for 4% to 10% of global emissions is a concerning reality (Berg *et al*., 2020).

In Kenya specifically, the textile and apparel sector faces challenges such as the generation of 400,000 tonnes of cotton waste annually and the disposal of 40% of imported clothes as textile waste (Sasi, 2022; Texfash, 2022). Despite these challenges, the sector contributes 0.6% to Kenya's GDP and has the potential to create over 200,000 direct jobs (Muindi, 2022; Mwangi, 2022). The Kenyan textile and apparel supply chain overseen by the Ministry of Trade, Investment, and Industry and supported by private sector associations and training institutes, encompasses various components, including input providers, yarn spinning companies, weaving, knitting, dying, finishing plants and mills, and firms involved in design and sewing (Malicha & Njoroge, 2020). Consequently, Kenya's textile and apparel supply chain is represented in Figure 1.
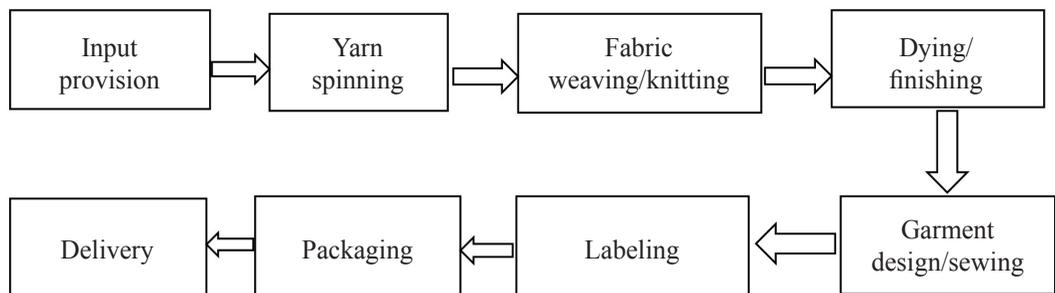

Figure 1: Kenya's textile and apparel supply chain

Given the pivotal role of the textile and apparel industry in the Kenyan economy and its potential threats to biodiversity, especially through greenhouse gas emissions, this study aims to fill the research gap by exploring the integration of green logistics in the textile supply chain. The goal is to examine environmental sustainability in supply chains as a crucial step towards mitigating biodiversity loss. This research contributes to the growing body of literature on sustainable practices within supply chains, particularly in the context of developing nations like Kenya.

In examining the textile supply chain's environmental sustainability, it is crucial to acknowledge the multifaceted contributions and challenges associated with the sector. While the economic benefits of a robust textile supply chain are evident in terms of employment generation and economic growth (Yaghin & Darvishi, 2020), the environmental ramifications, including waste generation and improper disposal cannot be overlooked (Yalcin-Enis et al., 2019). This dual nature of the textile supply chain necessitates a balanced approach that addresses both economic prosperity and environmental stewardship.

The geographical distribution of textile manufacturing centres with Mauritius leading in the contribution of textiles to total manufacturing, underscores the global significance of the industry (Syrowik, 2017). However, this also raises concerns about the environmental impact across various regions. For instance, despite not being among the top global contributors, the Kenyan textile and apparel sector presents its challenges, including substantial cotton waste generation and textile disposal issues (Smith, 2022; GreenTechTextiles, 2022). This dichotomy emphasises the need for localised strategies to enhance the sustainability of the textile supply chain, taking into account the unique challenges each region faces.

As the textile industry continues to grow in developing nations such as Kenya, adopting sustainable practices to mitigate the environmental footprint is imperative. Green logistics emerges as a viable solution, aligning with the global shift towards sustainability in supply chain management (Teixeira et al., 2018). The integration of green logistics into the textile supply chain can not only address environmental concerns but also contribute to economic development and social well-being (Gu et al., 2021).

The theory of Inclusive Green Economy (IGE) provides a comprehensive framework for understanding how green logistics can contribute to inclusive and sustainable development (Gu et al., 2021). By focusing on components such as procurement, production, warehousing, and transportation, green logistics aims to create a balance between economic growth and environmental stewardship. This inclusive approach addresses challenges such as poverty, planetary boundaries, and inequitable growth, making it particularly relevant in the context of developing nations (Ashfaq et al., 2020; Karaman et al., 2020).

The positive impact of green logistics is evident in various empirical studies across diverse contexts. Polish SMEs, Lithuanian logistics companies, Asian manufacturing firms, and Greek agri-food supply chains consistently demonstrate the benefits of adopting green logistics practices (Zowada, 2020; Trivellas et al., 2020; Vienazindiene et al., 2021). These studies highlight the potential for environmental and social sustainability, emphasising that green logistics is necessary for mitigating environmental harm and a strategic driver of profitability and trade facilitation.

The textile industry's significant contribution to pollution, accounting for 4% to 10% of global emissions (Berg et al., 2020), reinforces the urgency of implementing green logistics practices. In the Kenyan context, where the textile and apparel sector faces challenges in waste management and disposal (Sasi, 2022; Texfash, 2022), the adoption of green logistics becomes paramount. This aligns with global sustainability goals and addresses local issues related to waste generation and environmental degradation.

The challenges faced by the Kenyan textile and apparel supply chain, including the generation of 400,000 tonnes of cotton waste annually and the disposal of 40% of imported clothes as textile waste (Sasi, 2022; Texfash, 2022) underscore the need for targeted interventions. Despite these challenges, the sector's contribution to Kenya's GDP and its potential to create over 200,000 direct jobs highlight its socio-economic importance (Muindi, 2022; Mwangi, 2022). Therefore, integrating green logistics into the Kenyan textile supply chain addresses environmental concerns and enhances the sector's long-term viability and socio-economic impact.

The Kenyan textile and apparel supply chain structure, overseen by the Ministry of Trade, Investment, and Industry and supported by private sector associations and training institutes (Malicha & Njoroge, 2020) provides a framework for implementing green logistics practices. The involvement of various stakeholders, including input providers, yarn spinning companies, weaving/knitting/dying/ finishing plants and mills, and firms involved in design and sewing, offers multiple entry points for integrating sustainable practices (Malicha & Njoroge, 2020). This collaborative approach ensures that green logistics principles permeate every stage of the supply chain from raw material sourcing to the final product.

Therefore, the textile supply chain's pivotal role in global and national economies necessitates a holistic approach to address its economic benefits and environmental challenges. The adoption of green logistics emerges as a strategic solution, aligning with the global shift towards sustainability and inclusive green economies. Despite facing waste management issues, the Kenyan textile and apparel sector presents an opportunity to integrate green logistics practices, thereby enhancing environmental sustainability and ensuring the sector's long-term socio-economic impact. This research contributes to the growing literature on sustainable supply chain practices, particularly in the context of developing nations and underscores the importance of balancing economic growth with environmental stewardship in the textile industry.

Literature Review and Hypotheses Development

This study was grounded in the theory of the Inclusive Green Economy (IGE) that encourages environmental investments within the context of sustainable development. The Green Economy Initiative (GEI) is a United Nations Environment Programme (UNEP) initiative launched in 2008 and paved the way for green economy focusing on poverty eradication and sustainable development to be part of the 2012 Rio + 20 agenda as a tool for sustainable development (Alfredsson & Wijkman, 2014). The choice of the IGE for this study was based on the understanding that the textile supply chain could improve human well-being and social equity if well-managed to reduce ecological scarcities and environmental risks.

Environmental Sustainability

Environmental sustainability has become a focal point in the wake of escalating human activities threatening the planet's ecological balance. The unsustainable use of land, energy, and water, coupled with the overarching issue of climate change has prompted increased attention to the imperative of sustainable practices (Nobre *et al.*, 2016). The United Nations (UN) defines sustainability as the ability to meet present needs without compromising the ability of future generations to meet their own needs (Garren & Brinkmann, 2018). In essence, environmental sustainability demands a selfless perspective that prioritises the well-being of future generations.

The Planetary Boundaries (PB) concept, introduced in 2009 has played a pivotal role in defining operational parameters that align with environmental constraints (Li *et al.*, 2021). It establishes a framework within which humanity must operate to avoid irreversible environmental damage. Within the context of PB, sustainability requires a conscientious effort

to ensure that human activities remain within ecological boundaries. As such, this study adopts a comprehensive approach, recognising ecological, economic, and human dimensions as key sustainability indicators.

The research framework of this study revolves around the manipulation of green practices within the textile supply chain. The study focuses on green procurement, green production, green warehousing, and green transportation as integral components that collectively impact the overall sustainability of the textile supply chain. This conceptualisation draws inspiration from existing empirical studies, which are explored in subsequent sections to provide a robust foundation for the research.

Ultimately, the imperative of environmental sustainability is underscored by the need for responsible and conscientious practices in the face of growing environmental challenges. By aligning with the planetary boundary concept and recognising sustainability indicators across ecological, economic, and human dimensions, this study aims to explore the intricate relationship between green practices and the sustainability of the textile supply chain. The subsequent sections will delve into existing empirical studies to comprehensively understand the subject matter.

Green Procurement and Sustainability of the Supply Chain

Terman and Smith (2018) delved into the concept of green procurement, positioning it as a crucial aspect of sustainability initiatives. Motivated by the substantial body of literature advocating for sustainability policies in US local governments, the researchers argued that investing in green procurement represented a direct effort to align with these policies. Despite the prevailing discourse on sustainability, they identified a notable gap in the literature about the role of public procurement in promoting environmentally responsible behaviour.

Investigation conducted by Cankaya and Sezen (2018) in Turkey through a plant-level survey, scrutinised the impact of green supply chain practices, including green purchasing on sustainability performance. Their findings suggested that embracing green supply chain management positively affected sustainability performance. In a parallel study focusing on manufacturing firms in Pakistan, Khan and Qianli (2017) explored the relationship between green supply chain management and organisational performance. Although their sample of 218 firms indicated that green purchasing did not significantly influence organisational performance, the results added a layer of complexity to the overall understanding of the subject.

In Vietnam, Le (2020) addressed the escalating social responsibility and environmental concerns by exploring the impact of green practices on the performance of manufacturing enterprises specialising in construction materials. Emphasising the broader scope of the green supply chain management strategy in shaping social outcomes and addressing environmental issues, the study found that green practices such as green manufacturing and design, positively influenced environmental performance. However, the lack of specific mention of green procurement in the study underscored the need to explore this aspect further in the context of sustainability.

The divergent findings across studies with some indicating a positive impact of green purchasing on sustainability and others not, raise pertinent questions about the comprehensive influence of green procurement, which encompasses both sourcing and purchasing. The variability in outcomes suggests that the contextual nuances and specific practices within green procurement warrant deeper investigation to unravel the intricacies of its impact on sustainability. As the discourse on sustainability evolves, addressing these nuances becomes imperative for informed procurement

and sustainability policy decision-making. Therefore, we postulated that:

H01: Green procurement has no significant effect on the sustainability of the textile supply chain

Green Production and Supply Chain Sustainability

Green supply chain management has garnered significant attention in sustainability, particularly in the context of Small and Medium-sized Enterprises (SMEs) facing high failure rates. Mafini and Muposhi (2017) delved into this concern by examining 312 SMEs in Gauteng province, South Africa. Through the application of structural equation modelling, they found that green practices exhibited a positive influence on environmental collaboration. Notably, green production emerged as a key factor, exerting a more substantial impact.

Extending the exploration of green practices to Pakistan, Khan and Quanli (2017) conducted a study involving 218 firms in the manufacturing sector. Their findings revealed that the adoption of green manufacturing and related practices positively influenced the performance of manufacturing firms. This conclusion was drawn through exploratory factor analysis and simultaneous regression analysis, emphasising the broader positive ramifications of incorporating sustainable practices.

In the context of the Fourth Industrial Revolution (4IR) and the imperative of environmental sustainability, Rupa and Saif (2022) investigated the impact of green supply chain practices in Bangladesh. Their study revealed variations in the influence of these practices on resource consumption, waste disposal, profit, cost, and greenhouse gas emissions. Additionally, they established a significant positive effect of green practices on overall environmental sustainability. However, the specific nature of the green practices employed remained unclear.

Shifting the focus to the tourism industry in Vietnam, Nguyen *et al*. (2020) employed Smart PLS software to showcase the pivotal role of green supply chain management. The study underscored that such practices were precursors to a firm's corporate reputation, competitive advantage, and environmental performance. Despite the significance of their findings, the scholars needed to provide explicit details on the specific green practices analysed.

While existing research has underscored the importance of green supply chain practices in promoting environmental sustainability, there needs to be more literature regarding the impact of green production logistics on the sustainability of the Kenyan textile supply chain. This gap presents an opportunity for future research to explore and contribute to a more comprehensive understanding of sustainable practices in diverse industrial contexts. Because of this scarcity of interest, we postulated that:

H02: Green production has no significant effect on the sustainability of the Kenyan textile supply chain

Green Warehousing and Supply Chain Sustainability

Green warehousing has emerged as a critical element in enhancing supply chain sustainability, as evidenced by various studies examining its impact on different industries. Agyabeng-Mensah *et al*. (2020) employed a quantitative approach to investigate the role of green warehousing in Ghanaian manufacturing firms. Through PLS-SEM, the study revealed a positive correlation between green warehousing and economic performance, thereby influencing overall supply chain sustainability.

Bartolini *et al*. (2019) conducted a systematic review focusing on the environmental implications of warehousing practices. Recognising the significant contribution of supply chains to greenhouse gas emissions, the study highlighted a surge in interest in sustainability within the warehousing domain. Despite the increased attention, Bartolini *et al*. (2019) noted an absence of empirical data and case studies in the existing literature.

Further supporting the relevance of green warehousing, Ali *et al*. (2022) explored sustainability initiatives in frozen food supply chains in Saudi Arabia. Applying the triple bottom line approach and contingency theory, the study found that green warehousing contributed to green operations by conserving energy and resources and fostering a sustainable work culture. This approach led to the development of strategies that positively influenced overall sustainability performance.

In the context of the Malaysian food industry, Kamarulzaman *et al*. (2018) delved into the relationship between green warehousing and environmental sustainability. Concerns about unwanted emissions associated with warehousing led to their investigation. The study confirmed the adoption of green warehousing initiatives in Malaysia's food industry, showcasing a positive impact on overall performance and environmental sustainability.

While the existing body of research emphasises the significance of green warehousing in various sectors, the need for more literature on its application in the textile supply chain raises questions about its efficacy in promoting sustainability within this specific industry. This gap in knowledge serves as the foundation for exploring the potential impact and effectiveness of green warehousing in textile supply chain sustainability. As industries grapple with environmental concerns, understanding the applicability of green warehousing across diverse supply chains becomes crucial for fostering sustainable practices and mitigating the environmental impact of global business operations. Therefore, we presupposed that:

H03: Green warehouse has no significant effect on the sustainability of the textile supply chain

Green Transport Logistics and Supply Chain Sustainability

In recent years, the discourse on sustainable development has gained prominence with researchers delving into various aspects of green practices within logistics and supply chain management. Vienazindiene *et al*. (2021) conducted a comprehensive study in Lithuania, focusing on transportation and logistics companies to assess the impact of green transportation on sustainability. Employing a diverse range of analytical methods, including descriptive statistics, bivariate correlations, and linear regressions, their findings emphasised the pivotal role of green transportation as a significant predictor of environmental and developmental sustainability. This underlines the importance of adopting eco-friendly transport practices in fostering a sustainable future.

Lu *et al*. (2019) expanded the exploration of green transportation's impact by constructing an environmental logistics index. This index was instrumental in evaluating the overall impact of green transportation on logistics practices, revealing strong correlations with logistics performance, income, and regional factors. Their study reinforced the positive influence of green transportation and highlighted its potential as a catalyst for improved logistics performance and economic growth. Such insights guide policymakers and industry stakeholders in shaping sustainable logistics strategies.

In the context of a circular economy, de Souza *et al*. (2022) addressed the imperative of integrating green logistics practices, particularly in transportation. Their focus was motivated by the increasing concern over environmental pollution caused by plastic packaging. Employing the Analytic Hierarchy Process (AHP) approach, they critically evaluated various green logistics practices, identifying areas where ecological sustainability efforts fell short. Notably, green transportation emerged as one of the least prioritised aspects of environmental sustainability initiatives. This underscores the need for a holistic approach to green logistics, emphasising the significance of incorporating sustainable transportation practices in the broader framework of circular economy strategies.

In conclusion, the studies by Lu *et al*. (2019), Vienazindiene *et al*. (2021), and de Souza *et al*. (2022) collectively emphasise

the integral role of green transportation in achieving sustainability goals within the logistics and supply chain sector. As businesses and policymakers navigate the complexities of sustainable development, incorporating eco-friendly transportation practices emerges as a fundamental element in fostering environmental and economic sustainability. Therefore, a lack of interest in the impact of green transportation logistics was worrying and prompted the postulation that:

H04: Green transportation has no significant effect on the sustainability of the textile supply chain

Methods and Techniques

This research employed the Confirmatory Composite Analysis (CCA) technique to validate measurement models, employing PLS-SEM. The primary objective was to assess the impact of green logistics practices, utilising a reflective conceptual model within the PLS-SEM framework. As outlined by Dzigol *et al*. (2021), the multifaceted nature of green logistics includes various components such as green procurement [measured by purchasing (PT) and sourcing (SG)], green production [encompassing distribution (DN), material management (MM), product management (PM), and shipping (SP)], green warehousing [measured through Goods Dispatched (GD), Preparing Records (PR), Receiving Goods (RG), and Sorting (ST)], and green transportation [comprising Transport Control (TC), Transport Strategies (TS), and Vehicle Management (VM)]. Consequently, the conceptual model was constructed based on these 13 manifest variables that elucidate the four distinct components of green logistics.

Simultaneously, the endogenous variable, sustainability was explicated through three manifest variables: Ecological (ECOL), economic (ECON), and human (HUM). Figure 2 illustrates the conceptual model, portraying the reflective measurement and structural relationships. In the visual representation, latent variables are depicted with oval shapes, while rectangular shapes symbolise manifest variables.

Using PLS-SEM in conjunction with CCA enhances the robustness of the study by providing a systematic and affirmative approach to validate the conceptual model. This methodological choice aligns with the current trends in structural equation modelling and underscores the commitment to ensuring the accuracy and reliability of the measurement models. The comprehensive nature of the model, encompassing various facets of green logistics, contributes to a nuanced understanding of the relationships among different components and their collective impact on sustainability. In essence, the research framework serves as a valuable tool for organisations seeking to enhance their green logistics practices in pursuit of sustainable outcomes.

The choice of an observational cross-sectional design is justified by the study's objective to assess the current state of green logistics practices and their impact on sustainability at a specific time. This design allows data collection from multiple firms simultaneously, providing a snapshot of practices and outcomes that can be compared and analysed. Given the multifaceted nature of green logistics and the need to understand the interactions between different components and sustainability, a cross-sectional design is appropriate as it facilitates the identification of correlations and patterns across a diverse sample. Moreover, this design is efficient regarding time and resources, making it suitable for examining practices within a specific industry and geographic region.

Sampling Technique

To select the 265 staff members, a stratified random sampling technique was employed to ensure representation from different sections of the supply chain, including production, logistics, customer service, and transport management. This approach involved dividing the population of staff members into strata based on their roles and then randomly selecting participants from each stratum. This method enhances the transparency and replicability of the
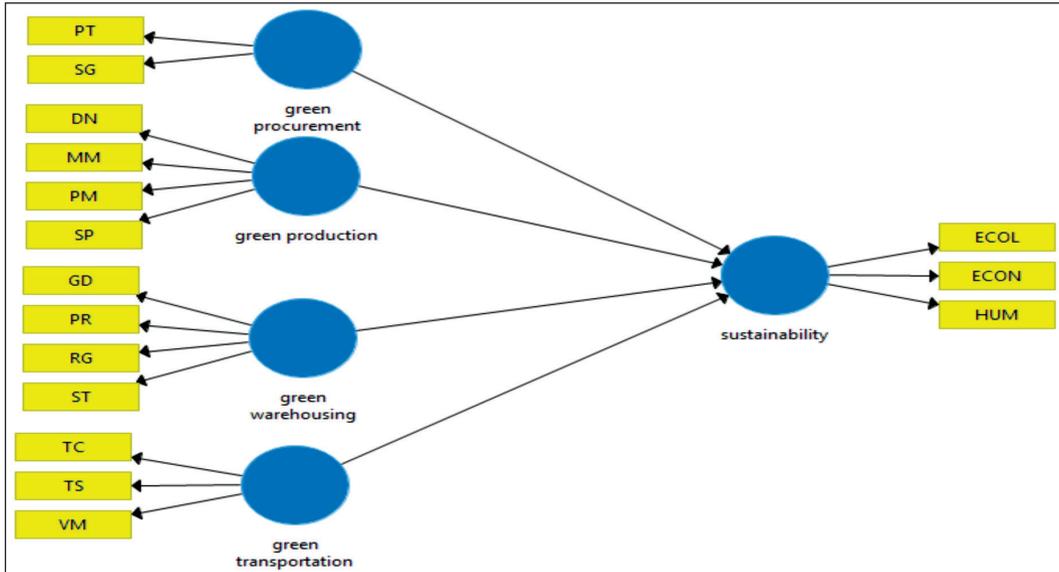
Figure 2: Conceptual model

sampling process, providing a comprehensive representation of the staff involved in green logistics practices.

The research methodology employed in this study was anchored in a robust conceptual model that served as a guiding framework for the systematic collection of data. The primary instrument for data gathering was a meticulously designed structured questionnaire implemented through a comprehensive survey. The survey targeted employees across various sections integral to the supply chain, encompassing production, logistics, customer service, and transport management. Nairobi City County was strategically chosen as the research setting due to its substantial concentration of textile and apparel firms. This geographical focus was driven by the alarming magnitude of textile waste generated by these establishments, posing significant threats to the environment and human well-being, as highlighted by Osoro and Shale (2019).

A total of 200 structured questionnaires were distributed across 26 textile and apparel firms within Nairobi City County. The enthusiastic response from participants resulted in 160 fully completed questionnaires. However, a meticulous screening and cleaning process was undertaken to ensure data integrity. Consequently, 12 incomplete questionnaires were identified and seven were excluded from the analysis. The final dataset comprised 141 meticulously screened and cleaned questionnaires, meeting the stringent requirements for PLS-SEM analysis, as advocated by Hair *et al*. (2017). This rigorous approach ensures the reliability and validity of the collected data, laying a solid foundation for the subsequent analytical phases of the research.

Analysis

The robustness of the conceptual model was thoroughly assessed through a meticulous PLS-SEM evaluation, focusing on the pivotal aspects of construct reliability. Employing Cronbach's alpha and Composite Reliability (CR) as the yardsticks for reliability, the findings elucidated in Table 1, assert the model's commendable performance. Notably, both Cronbach's alpha and CR values exceeded the benchmark of 0.7, attesting to an exemplary internal consistency in line with established standards (Hair *et al*., 2017). Furthermore, a comprehensive examination of the Average Vvariance Extracted (AVE) values revealed a noteworthy pattern with all values surpassing the 0.5 threshold. This

outcome underscores the model's adherence to convergent validity, fortifying its credibility and reinforcing the soundness of the conceptual framework.

PLS-SEM was well explained by emphasising its appropriateness for exploratory and confirmatory research in complex models with multiple constructs. The study employed PLS-SEM to explore the relationships between green logistics practices and sustainability outcomes, enabling researchers to handle reflective and formative measurement models simultaneously. The key model outputs, including path coefficients, R-squared values, and reliability indicators were interpreted to understand the significance and strength of the hypothesised relationships.

From Table 2, the Fornell-lacker criterion, a widely recognised measure in assessing discriminant validity, definitively confirmed its acceptability for our study. Notably, the outer diagonal values displayed in the table were consistently higher for all constructs, indicating a robust distinction between the variables under consideration. This confirmation underscores the reliability and validity of our research findings, providing a solid foundation for further analysis and interpretation.

The substantial R-squared value of 0.697, as depicted in Figure 3, signifies the influential role of green logistics practices, elucidating a noteworthy 69.7% of the variability in sustainability outcomes. This robust correlation underscores the critical impact of eco-friendly logistical approaches on overall sustainability metrics.

The study's findings, as depicted in Table 3, highlight the noteworthy path coefficients associated with various factors influencing sustainability. Specifically, the positive and significant path coefficients for green procurement ($b = -0.277$, $p < 0.05$), green production ($b = 0.316$, $p < 0.05$), and green transportation ($b = 0.345$, $p < 0.05$) underscore their crucial roles as predictors of sustainability. On the contrary, green warehousing ($b = -0.002$, $p > 0.05$) exhibited insignificance in this context. These results emphasise the importance of strategic emphasis on green procurement, production, and transportation practices for organisations aiming to enhance their sustainability initiatives.

Table 1: Suitability of conceptual model

Construct	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Green procurement	0.880	0.944	0.893
Green transportation	0.878	0.926	0.806
Green production	0.874	0.914	0.726
Sustainability	0.856	0.913	0.779
Green warehousing	0.854	0.899	0.692

Table 2: Discriminant validity

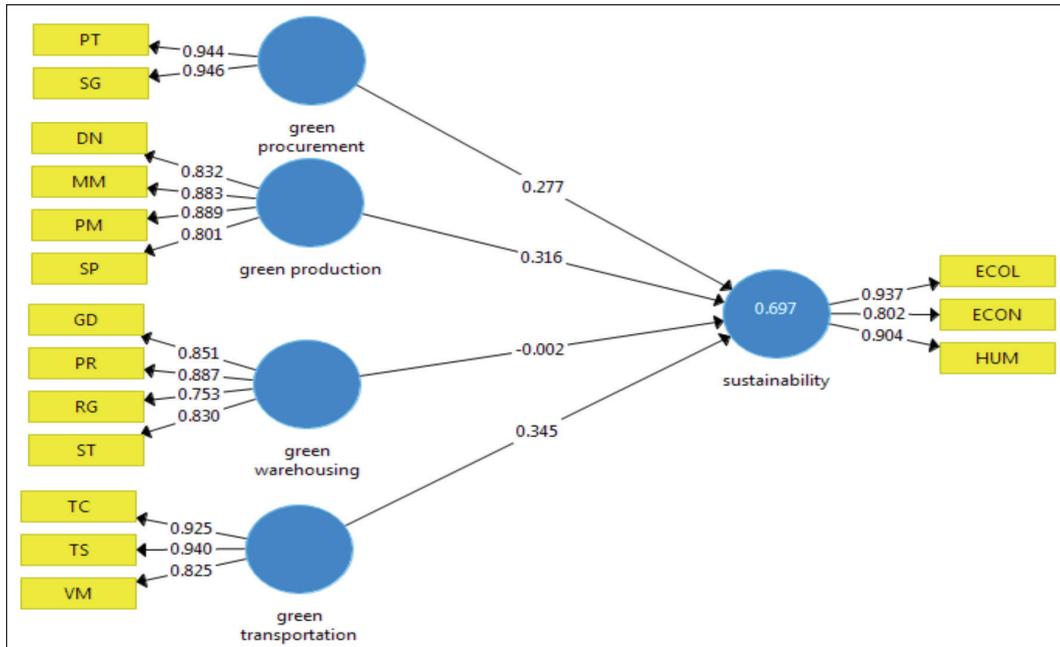| Construct	Green Procurement	Green Production	Green Transportation	Green Warehousing	Sustainability
Green procurement	0.945				
Green production	0.772	0.852			
Green transportation	0.610	0.701	0.898		
Green warehousing	0.729	0.826	0.717	0.832	
Sustainability	0.730	0.770	0.734	0.708	0.883

Figure 3: Outer and inner valuation

Table 3: Path coefficients

Construct	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P-values
Green procurement	0.277	0.252	0.139	1.993	0.047
Green production	0.316	0.317	0.145	2.181	0.030
Green transportation	0.345	0.346	0.130	2.652	0.008
Green warehousing	-0.002	0.020	0.135	0.015	0.988

Results and Discussion

The research focusing on the impact of green procurement logistics on sustainability performance within the textile supply chain in Nairobi City County, Kenya offers valuable insights into the interconnectedness of sustainable practices and environmental concerns. The detailed PLS-SEM analysis revealed specific statistics and figures supporting the findings. For instance, the positive and significant path coefficients for green procurement (b = 0.277, p < 0.05), green production (b = 0.316, p < 0.05), and green transportation (b = 0.345, p < 0.05) underscore

their crucial roles as predictors of sustainability. The study reveals a substantial and positive influence of green procurement on sustainability, particularly in the context of waste generation in urban centres, as highlighted by the National Environment Management Authority (NEMA) in 2015. The textile industry, often associated with significant waste generation (Yalcin-Enis *et al*., 2019) becomes a critical area for the application of green procurement strategies.

The findings align with existing literature on green procurement's positive impacts in various sectors globally (Shen *et al*., 2017; Guo

et al., 2020), emphasising its cross-sectoral relevance in sustainable development (Chersan *et al.*, 2020). The study's robust R-squared value of 0.697 further signifies the influential role of green logistics practices, explaining 69.7% of the variability in sustainability outcomes. This underscores the critical impact of eco-friendly logistical approaches on overall sustainability metrics. The documented association between the textile industry and substantial waste generation underlines the potential for green procurement to contribute significantly to waste reduction, addressing broader sustainability goals. The study augments existing knowledge and underscores the urgency and relevance of integrating green procurement strategies into business practices, especially in developing nations like Kenya.

Moving forward, it is crucial to acknowledge the need for a comprehensive approach to sustainability within the textile industry, incorporating green production and transportation practices. The research findings indicate a significant positive correlation between green production and sustainability, supported by a path coefficient of 0.316 (p < 0.05). This reinforces the importance of adopting eco-friendly production strategies. The adoption of green production practices has emerged as a strategic move for firms navigating competitive markets (Du *et al.*, 2018), aligning with Corporate Social Responsibility (CSR) indices and addressing the pressing issue of post-production textile waste. The study emphasises the urgent need for textile firms in Kenya to adopt green production strategies actively, contributing to a more sustainable future.

In the realm of transportation logistics, the study highlights the pivotal role of green transportation in fostering sustainability within the textile supply chain. The positive correlation between green transportation practices and sustainability outcomes, evidenced by a path coefficient of 0.345 (p < 0.05), underscores the potential of environmentally friendly transportation solutions to mitigate environmental burdens and reduce waste

generation. The adoption of green transportation not only aligns with sustainability goals, but also safeguards the economic viability of the textile industry with additional health benefits for employees. Embracing green transportation becomes a strategic imperative for promoting overall well-being and environmental sustainability within the textile sector.

However, the research also delves into an unexpected aspect concerning the insignificance of warehousing logistics on overall sustainability within textile supply chains. The path coefficient for green warehousing was -0.002 (p > 0.05), indicating an insignificant impact on sustainability outcomes. These challenge prevailing assumptions and call for a deeper exploration of the complexities of conducting sustainability studies. While warehousing activities are traditionally associated with environmental pollutants (Shearston *et al.*, 2020), the study suggests that greening warehousing has failed to impact sustainability within textile supply chains significantly. This unexpected disconnect emphasises the need for a more nuanced approach to environmental studies and urges scholars and practitioners to delve deeper into the intricate dynamics of supply chain logistics.

Key Policy Recommendations

The findings of this study have broader implications for policy and practice in the Kenyan textile industry and beyond. Key policy recommendations emerge to guide stakeholders in the textile industry and policymakers toward fostering a more sustainable future: To promote sustainable practices within the textile industry in Nairobi City County, a comprehensive set of policy recommendations is proposed. These strategies are aimed at integrating green procurement, promoting eco-friendly production, advancing green transportation solutions, rethinking warehousing practices, adopting a comprehensive national approach, shifting towards formative constructs in research, and leveraging the Green Economy Strategy.

Firstly, the integration of green procurement strategies is vital. Textile firms should be encouraged to prioritise environmentally friendly materials and processes in their sourcing and purchasing practices. Collaborative efforts between the government and industry stakeholders are necessary to develop and enforce policies that incentivise and reward the adoption of green procurement practices. By aligning these strategies with broader sustainability goals, the textile industry can make significant strides toward a more environmentally conscious and responsible approach.

Secondly, promoting green production practices is crucial for enhancing the overall sustainability of the textile industry. Policymakers should incentivise companies to embrace eco-friendly production technologies and processes through subsidies, tax breaks, and other supportive measures. Industry associations and regulatory bodies can be pivotal in disseminating best practices and facilitating collaboration among firms. This collaborative approach will create a more sustainable and environmentally friendly production ecosystem.

The integration of green logistics practices contributes to sustainability within the textile sector and aligns with global trends towards environmentally conscious business operations. For policymakers, the study underscores the need for comprehensive policies that promote green procurement, production, and transportation. These policies can incentivise firms to adopt sustainable practices, thereby reducing environmental impacts and enhancing competitiveness in the global market.

Moreover, the insights gained from this research can be applied to other industries facing similar sustainability challenges. The systematic approach to validate green logistics practices through PLS-SEM can serve as a model for other sectors aiming to enhance their sustainability initiatives. By adopting similar frameworks, industries can better understand the relationships between different components of their supply chains and their collective impact on sustainability.

For the Kenyan textile industry, specifically, the study highlights the importance of strategic emphasis on green procurement, production, and transportation. Policymakers should focus on creating an enabling environment that supports these practices through subsidies, tax incentives, and infrastructure development. Furthermore, the insignificant impact of green warehousing on sustainability suggests a need for targeted research to explore the underlying factors and develop more effective strategies for this component.

Additionally, policymakers should focus on advancing green transportation solutions within the textile supply chain. Incentivising environmentally friendly transport modes, providing infrastructure support for electric vehicles, and implementing policies that discourage traditional transport logistics from contributing to greenhouse gas emissions are essential. Government initiatives should prioritise enhancing overall sustainability in urban transportation centres, thereby reducing the environmental impact of the textile supply chain.

Furthermore, the role of warehousing practices in environmental sustainability should be reevaluated. While existing research challenges the assumed impact of greening warehousing, policymakers and industry stakeholders should conduct further studies to understand the specific nuances of warehousing in the textile supply chain. Policies should be tailored to address identified complexities and guide firms toward more effective and sustainable warehousing practices.

A holistic and comprehensive national approach is recommended to enhance future investigations and policy formulation. Researchers and policymakers should broaden their focus to include textile and apparel firms nationwide. This approach will provide a more nuanced understanding of sustainability practices across diverse urban landscapes, allowing for the tailoring of policies to specific regional needs.

To address the limitations of reflective constructs in the methodology employed in this study, a shift towards formative constructs in future research is suggested. Building on the findings of this study, future research should explore several specific areas to enhance further our understanding of green logistics practices and their impact on sustainability. Firstly, there is a need for longitudinal studies that examine the long-term effects of green logistics practices on sustainability outcomes. Such studies can provide insights into the sustained impact of these practices and identify any evolving trends or emerging challenges. Future research should investigate the role of green warehousing in greater detail. The unexpected finding of its insignificance in this study calls for a deeper exploration of the complexities involved in greening warehousing activities. Researchers should consider adopting formative constructs to capture better the causal relationships between warehousing indicators and overall sustainability.

Additionally, comparative studies across different industries and geographic regions can provide a more comprehensive understanding of how green logistics practices can be effectively implemented in diverse contexts. Such research can identify best practices and facilitate knowledge transfer between sectors and regions. Lastly, the potential impact of emerging technologies on green logistics should be a focal point for future investigations. Technologies such as blockchain, the Internet of Things (IoT), and Artificial Intelligence (AI) have the potential to revolutionise supply chain management and enhance sustainability. Research should explore how these technologies can be integrated into green logistics frameworks to optimise performance and achieve sustainability goals. This approach can explore whether green warehousing significantly impacts sustainability and address potential causal relationships between indicators and constructs. By adopting more comprehensive research methodologies, policymakers can make informed decisions to enhance sustainability within the textile industry.

Lastly, leveraging the national Green Economy Strategy and Implementation Plan for 2016 to 2030 is recommended. The Kenyan textile industry should formulate policy guidelines aligned with this strategic framework. This involves establishing standards, requirements, and robust enforcement mechanisms for green logistics. The textile sector can contribute substantially to a sustainable and eco-friendly future by aligning industry practices with the broader green economy strategy.

Consequently, the integration of these policy recommendations will not only contribute to the environmental sustainability of the textile industry in Nairobi City County but also serve as a model for other regions. By fostering collaboration between the government, industry stakeholders, and researchers, these strategies can pave the way for a more sustainable and eco-friendly future in the Kenyan textile sector.

Conclusions

In conclusion, the research findings shed light on the pivotal role of green procurement, production, and transportation practices in bolstering sustainability within the textile supply chain. The positive correlation between these eco-friendly practices and environmental sustainability underscores the pressing need for textile firms in Kenya to embrace and actively integrate such strategies into their operations.

The unexpected revelation of the insignificance of warehousing logistics challenges existing assumptions, prompting a re-evaluation of environmental studies within the broader context of supply chain logistics. This surprising outcome suggests that the environmental impact of warehousing, though previously considered a significant factor, may not be as pronounced as anticipated. This calls for a nuanced understanding of the various elements contributing to sustainability within the textile industry.

The outlined key policy recommendations serve as a comprehensive roadmap for industry stakeholders and policymakers, offering practical

steps to navigate the intricacies of sustainability in the textile sector. From the incorporation of green procurement strategies to the promotion of environmentally friendly production and transportation practices, these recommendations strive to foster a holistic and sustainable approach. By embracing these recommendations and promoting stakeholder collaboration, the Kenyan textile industry can lead by example in sustainable development, contributing to a resilient and eco-friendly future. Bold initiatives are required to operationalise these findings and foster sustainable practices within the Kenyan textile industry which include the following:

(1) Integrated green procurement strategies: Textile firms should prioritise environmentally friendly materials and processes. Collaboration between government and industry stakeholders is crucial to incentivise and enforce policies that reward sustainable procurement practices. This alignment will significantly advance environmental goals and regulatory compliance.

(2) Promotion of eco-friendly production: Policymakers should incentivise the adoption of eco-friendly production technologies through subsidies and tax breaks. Industry associations can facilitate knowledge sharing and collaboration among firms to accelerate the transition to sustainable production practices.

(3) Advancement of green transportation solutions: Green transportation is pivotal in reducing carbon footprints and enhancing logistical efficiency. Policymakers should incentivise the adoption of electric vehicles and sustainable transport modes, supported by infrastructure development and regulatory frameworks that discourage traditional transport practices harmful to the environment.

(4) Rethinking warehousing practices: Despite the study's findings, further research and targeted policies are needed to understand and optimise the environmental impact of warehousing activities within textile supply chains. This includes exploring innovative technologies and operational practices to minimise environmental footprints while enhancing logistical efficiency.

(5) Comprehensive national approach: A holistic strategy integrating green logistics across Kenya's textile sector is essential. Policymakers should leverage frameworks like the Green Economy Strategy to establish robust standards and enforcement mechanisms. This approach ensures alignment with national sustainability objectives and enhances the sector's global competitiveness.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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