

Green logistics adoption and operational performance within the road freight sector: The moderating role of management commitment

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ABSTRACT

The road freight sector plays a pivotal role in economic development as it facilitates the movement of physical flows in both domestic and international supply chains. However, its significant contribution to greenhouse gas (GHG) emissions has made it a major contributor to climate change. Despite urgent calls for green logistics initiatives to mitigate these effects, adoption rates remain low, especially in developing countries. This study investigates how the adoption of green logistics practices can influence the operational performance of firms in the Zimbabwean Road freight sector. This study also explores the moderating role of management commitment in the relationship between the adoption of green logistics practices and operational performance. To achieve this, an explanatory survey was conducted with 184 employees from randomly selected companies in the road freight sector. The findings reveal that the adoption of green logistics practices positively influences operational performance. In addition, this study found that management commitment moderated this relationship. It is worth noting that this study represents the first study that examines the effect of adopting green logistics on operational performance in Zimbabwe, thus providing a novel contribution to the logistics literature. Additionally, it extends the knowledge on green logistics adoption within the sub-Saharan region and other developing parts of the world. Furthermore, this study recommends that policymakers collaborate with key stakeholders to accelerate the adoption of green logistics practices and

embrace modern technologies to reduce greenhouse gas emissions.

KEYWORDS: Greenhouse Gas Emissions · Green Logistics · Operational Performance · Road Freight Transport · Sub-Saharan region

1 INTRODUCTION

The activities of firms in the road freight sector are widely acknowledged as major contributors to environmental degradation, pollution, and climate change. As the world's population continues to increase, there is noticeable growth in global economic activity, which further increases the demand for logistics and transportation services. Consequently, there is growing concern regarding the impact of these trends on carbon emissions in the transport sector [1]. Gialos et al. [2] report that the transport sector is accountable for 14% of the total global greenhouse gas emissions [3]. The urgent need to address climate change issues and mitigate the environmental effects of road freight transport operations has captured the attention of the public, governments, investors, media, non-governmental organizations, and transport operators [4]. For instance, many European countries have taken significant steps to implement various initiatives such as standards, an International Operator Licence and ADR training certificate for operators of haulage trucks exceeding 3.5 tonnes, banning the importation of second-hand vehicles, promoting the use of electric vehicles, and harnessing solar power energy [5]. Moreover, certain companies in the developed world have voluntarily adopted eco-haulage systems to enhance carbonization and transparency, where companies disclose their greenhouse gas emissions to the public as part of their commitment to environmentally sustainable practices [4].

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Owing to growing concerns about environmental sustainability, green logistics has surfaced as an important topic in the global transportation sector. The African continent is no exception, as many countries are grappling with the effects of climate change, extreme weather conditions, and resource scarcity. The transport sector in most countries on the continent faces significant challenges characterized by poor road infrastructure, inadequate maintenance, and high levels of traffic congestion. Moreover, there has been an upsurge in carbon emissions, attributable to the rapid pace of industrial expansion and increased consumption of fossil fuels [6]. Furthermore, the continent is witnessing an increase in trade activities, urban expansion, and industrial growth, all of which strain the existing transportation infrastructure [7]. Despite these misfortunes, the adoption of green logistics practices remains low, particularly in the road freight sector. This is primarily due to the substantial costs associated with implementing such practices, absence of supportive legislative structures, and insufficient incentives. Several initiatives have been proposed to accelerate the adoption of green logistics practices, but their effectiveness remains questionable, as adoption rates continue to be very low.

The current state of logistics operations for firms in the Zimbabwean Road freight sector is marred by unsustainable practices. This is evidenced by the increased number of accidents, poor vehicle maintenance, suboptimal routing, and use of outdated technologies. As a result of this multifaceted problem, the country has witnessed an increase in fossil carbon emissions, from 10 metric tons in 2010 to 10.86 metric tons in 2019, contributing to 3% of the total global carbon emissions [7]. In response to this environmental crisis, the government implemented several laws, such as the Atmospheric Pollution Prevention Act (Chapter 3:18) and the Environmental Management Act (EMA) (Chapter 9). In addition, the government, through Statutory 89 of 2021, banned the importation of second-hand private vehicles over 10 years of age. Despite these concerted efforts, the levels of carbon emissions remain high, prompting a crucial inquiry into the extent of the adoption of green logistics in the road freight sector. Although there is a relatively well-developed body of literature on green logistics practices in African countries [8, 9], evidence suggests that there is a paucity of research on the adoption of green logistics practices in the road freight sector in developing countries. Likewise, there is also a scanty of studies that have examined the moderating role of management commitment on the relationship between green logistics adoption and operational performance. For example, [8] published an article that focused on the impact of green logistics on the performance of commercial state corporations in Kenya. A study by [10] focused on integrating green logistics into the operational performance of manufacturing

organizations in Brazil. Another study by [11] studied the moderating role of agility on the influence of green logistics practices on the operational performance of 2000 European companies.

Based on the aforementioned, this study seeks to narrow this gap, thereby enriching green logistics literature. Specifically, it analyzes how the adoption of green logistics practices, such as green transportation, green purchasing, green packaging, and reverse logistics, can influence operational performance and establishes the moderating role of management commitment on the influence of green logistics adoption on the operational performance of firms in the road freight sector. To achieve these objectives, this study is structured as follows. First, it focuses on the concepts of green logistics and operational performance by describing existing literature in this field and building a set of hypotheses. The next section presents the methods used in this study. Finally, the article discusses the study's results, discussion, and implications are presented.

2. THEORY AND HYPOTHESES

2.1 Theoretical Framework

The current study is grounded in stakeholder and resource-based theories. According to the stakeholder theory, governmental policies, employees, and top management are critical stakeholders whose involvement significantly influences the adoption of green logistics practices. Existing literature confirms a consensus that stakeholders' pressure or demands can drive greater sustainability adoption [12, 13]. Meixell and Luoma [14] further argue that recognising and addressing organisational stakeholder interests can raise sustainability awareness and enhance operational performance. Conversely, resource-based theory posits that organisations must possess strategic bundles of resources and capabilities that are crucial for their survival, growth, and overall success [15]. This idea is supported by [16], who proposes that organisations leveraging supply chain sustainability outperform their less sustainable counterparts. Additionally, McWilliams and Siegel [17] explain that sustainability-focused organisations are associated with higher stock value, increased profits, reduced risk, positive reputation, and greater innovation, among other benefits. Given the relevance of resource-based theory to the effective adoption of green logistics practices, the current study aims to investigate how the adoption of green logistics practices can influence the operational performance of road freight companies.

2.2 Green Logistics

Green logistics is a business approach aimed at reducing the environmental impact of the flow of inventory, funds, and related information from the

point of origin up until they reach the end-user [18]. In the same way, Sarkis et al. [19] emphasised that green logistics entails incorporating environmental considerations into all aspects of logistics, such as sourcing, inventory management, warehousing, transportation, and distribution. Moreover, [20] asserts that green logistics serves as a supply chain management function with the primary objective of reducing the environmental and energy footprint of freight distribution. Wang et al. [21] elaborate that green logistics is a comprehensive framework for eco-efficient management of products and information from the point of origin to the point of consumption to meet or exceed customer needs. At its core, green logistics is focused on reducing energy consumption and limiting carbon emissions. Key components of green logistics include green transportation, green packaging, green purchasing, and reverse logistics [22, 23, 24].

2.3 Operational Performance

Operational performance is defined as the output or result achieved through unique operational capabilities [25]. The literature provides theoretical support, emphasising the significance of cost, quality, flexibility, and delivery as indicators of operational performance [26, 27, 28]. In addition, the literature shows that specific operational performance measures such as product quality, cost, delivery, and production flexibility distinguish between high and low performing firms [29]. In a similar vein, Miller and Roth [30] explained that cost, quality, delivery, and flexibility are the key measures of operational performance. Moreover, operational performance has been linked to higher profitability, reduced production costs, lower procurement costs, and improved intangible performance [31]. However, Narasimhan and Das [32] observed that operational performance is susceptible to several impediments, such as management apathy, lack of planning, inadequate information, outdated technology, and resistance to change. In this study, operational performance was defined in terms of cost, quality, and flexibility.

Management Commitment

Management commitment is the level of dedication and support shown by an organisation's leadership towards a specific initiative, project, or goal [33]. Management commitment can be demonstrated through a variety of actions, such as allocating resources and budgets for green logistics projects, establishing clear sustainability goals, providing employee training and awareness programmes, and incorporating green practices into the overall strategy of the organization. Top management is a critical success factor in the organisational environment, sustainability, implementation, and performance [34]. The stakeholder theory indicates that management is one of the powerful stakeholders who can significantly impact an organisation's environmental performance [35]. Top managers are

strategically positioned as they guide the direction of organisational activities, efforts, and actions, and ultimately, they determine the organisation's destiny. In addition, top management has the greatest influence through the provision of vision, strategies, and direction for an organisation towards the adoption of sustainable business practices [36].

2.4 Hypotheses Development and conceptual framework

There is a consensus in the literature that green transportation positively influences operational performance [37, 38]. Green transportation involves the adoption of low-carbon transportation practices with less environmental impact on the planet. According to [39], green transportation encompasses route optimisation, mode selection, load optimisation, multimodal transportation, and a reduction in trip frequency. A study conducted by [40] indicates that green transportation can lead to cost savings, particularly through reduced fuel consumption and maintenance costs. On the other hand, a study by [41] established that the use of intelligent transport systems can optimise routes and improve fuel consumption for firms in the road freight sector. Moreover, [42] and [43] explained that electric vehicles have lower fuel and maintenance costs compared to gasoline-powered vehicles, which can translate into significant savings for organisations that operate large vehicle fleets. Green transport has been found to reduce greenhouse gas emissions and air pollution, ultimately leading to improved environmental performance [44, 45]. Furthermore, [46] explained that green transportation can be enhanced through proper driver behavior. This finding is supported by [47], who emphasised that driver behaviours such as faster acceleration, braking, and engine idling while the vehicle is stationary or offloading negatively affect fuel consumption and significantly increase carbon emissions output. In addition, [48] revealed that optimising vehicle loading is crucial to enhancing environmental and operational performance. Other scholars have pointed out that when vehicle loading is optimised, the fuel consumption per tonne transported significantly decreases [49, 50]. Proper vehicle maintenance has been identified as a key factor in reducing accidents, breakdowns, oil spillage, and congestion, leading to a greener environment [51]. Therefore, this study hypothesised that:

Hypothesis H1a. Green transportation positively affects operational performance.

Zhang and Zhao [52] have asserted that green packaging involves eco-friendly and sustainable materials in the packaging process. They explained that the goal of green packaging is to minimise the negative effects of packaging waste on the environment throughout its entire lifecycle. Green packaging entails the use of sustainable, biodegradable, reusable, and recyclable

materials in preference to conventional plastic materials. A study by [16] found that green packaging goes beyond protecting the primary product but also lessens the environmental impact of packaging waste. Likewise, [53] noted that returnable transport packaging (such as logistics containers, drums, barrels, crates, pallets, trays, and bins), which are made of materials such as plastic, metal, and wood, minimises the risk of damage and optimises product safety and operational performance. This view is supported by [54], who observed that the adoption of returnable transport packaging enhances environmental, operational, and economic performance. Therefore, this study hypothesised that:

Hypothesis H1b. Green packaging positively affects operational performance.

The existing literature consistently supports a positive relationship between green purchasing and operational performance [55, 56, 57]. Zhu et al. [58] have observed that, in the face of increased competition and stringent regulations, adopting green purchasing has become a pivotal strategy for enterprises striving to achieve environmental sustainability and enhance performance. Liao and Rittscher [59] asserted that green supplies play a crucial role in managing supply networks with eco-friendly, socially responsible, and economically responsible practices. This entails minimising waste generation and conserving energy throughout the product's life cycle. On the other hand, Nderitu and Ngugi [60] found a positive effect between green purchasing and firm performance. Similarly, [61] examined the impact of green procurement practices on performance and concluded that green procurement initiatives significantly contribute to overall performance. Additionally, [62] conducted a quantitative study to establish the green procurement practices and supply network performance of firms listed in Nairobi. The study revealed that the implementation of green procurement practices can enhance customer service, reduce ordering costs, and lower inventory costs. Furthermore, [57] emphasised that green purchasing can lead to cost reduction and savings through life cycle assessment and whole-life costing. Therefore, this study hypothesised that:

Hypothesis H1c. Green purchasing positively influences operational performance.

There is a consensus in recent literature that reverse logistics positively influences operational performance [63]. Rabinovich and Knemeyer [64] assert that the implementation of reverse logistics can improve the financial performance of organizations. In addition, reverse logistics also offers opportunities for firms to enhance their environmental performance and gain competitive advantages in the market. Similarly, [65] highlights that the adoption of reverse logistics

reduces supply chain costs and increases process efficiency. In the same way, [66] explains that recycling and remanufacturing techniques not only contribute to environmental sustainability but also enhance the financial performance of the supply chain and increase customer satisfaction. Reusing items brings economic advantages by reducing disposal, procurement costs, inventory, shipping, and maintenance of new items while also generating income from recovered resources [67, 68]. Additionally, recycling reduces landfill waste, preserves natural resources, saves energy, lowers greenhouse gas emissions, and creates new job opportunities [69]. These findings are consistent with those of [70], who indicated that recycling strategically reduces energy consumption, air pollution, and reliance on fresh raw materials. Moreover, a study by [71] on the relationship between reverse logistics practices and performance revealed that higher adoption of remanufacturing is crucial in enhancing organisational and operational performance. Therefore, this study hypothesised that:

Hypothesis H1d. Reverse logistics positively influences operational performance.

Existing literature on the relationship between green logistics adoption and operational performance provides valuable insights into the potential benefits of adopting environmentally friendly practices [8, 11]. However, there is a lack of comprehensive studies that investigate the moderating role of management commitment on the influence of green logistics adoption on operational performance. Management commitment plays a critical role in the implementation of environmental management systems and initiatives [72, 73]. Top management determines, formulates, and implements various strategies that promote the adoption of sustainability initiatives [74]. A committed top management provides a conducive environment for employees to enhance environmental initiatives [33]. Employees must be recognised, appreciated, rewarded, and motivated to achieve higher levels of sustainability performance [33, 75]. Therefore, it is plausible to assume that management commitment moderates the effect of green logistics adoption on operational performance. Thus, it is hypothesised that:

Hypothesis H2. Management commitment moderates the effect of green logistics adoption on operational performance.

Drawing from the above discussion and hypothesized relationships, the conceptual framework of the study is presented in Figure 1.

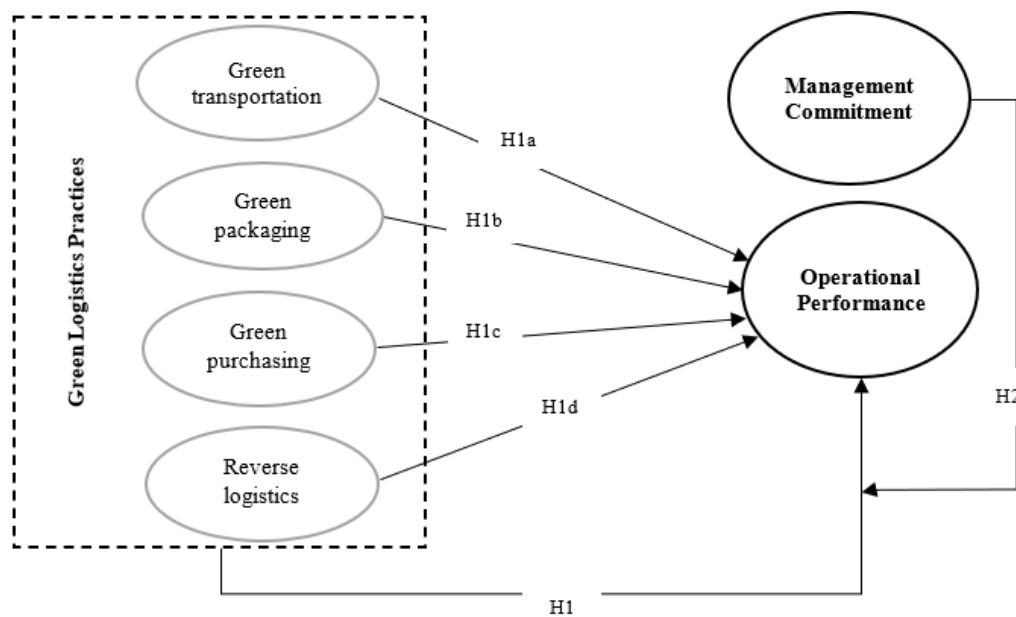


Figure 1: Conceptual framework

3. METHODOLOGY

3.1 Sample

An explanatory research design was employed to identify cause-and-effect relationships between the study variables [76]. A target population of 350 respondents was drawn from randomly selected road freight companies in Harare, Zimbabwe. Using the RAOSOFT sample size of 184 respondents was obtained using the RAOSOFT sample size calculator. Permission to collect data was sought from each organization before the questionnaires were distributed. Respondents were informed about the purpose of the research and invited to participate in the study. The researchers self-administered the questionnaires to 184 participants. The researchers collected data by physically visiting the road freight companies. The data collection period was between November and December 2022, to allow respondents sufficient time to complete the questionnaires. After data were collected, they were sorted and cleaned for statistical analysis. Of the 184 distributed questionnaires, 166 were completed and returned, yielding a high response rate of 90.2%. Male respondents dominated the study, comprising (71.4%) of the participants, and the majority (75%) were aged between 31 and 50 years old. The profile of the respondents showed a mixed group of respondents (in terms of gender and age), providing the study with a variety of perspectives. Most respondents (54%) worked in the operations department, (33%) in the procurement department, and 13% in the finance department (13%). People from these departments provide critical information, because they are knowledgeable about green logistics and operational performance.

3.2 Measurement

To measure all variables, a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used. The questionnaire items were borrowed from related studies and modified to align with this study. Green transportation was measured using items adapted from [2, 39]. A sample item for green transportation was “The company can use alternative fuels such as biofuels and electric power.” The items used to measure green packaging were adapted from [16, 53, 54]. A sample item for green transportation was “The company used smart packaging to optimize transportation routes, reduce delivery times, and prevent product damage.” Green purchasing was measured using items adapted from previous studies [55, 56, 60]. A sample item for green purchasing was “Our company can purchase vehicles that emit lower levels of pollutants such as nitrogen oxide, carbon monoxide, and particulate matter.” Reverse logistics were measured using items adapted from [8, 11, 73]. A sample item for green purchasing was, “Our company is involved in scrap sales, resale of motor spares, and non-reusable motor spares.” Management commitment was measured using items adapted from [33, 36]. A sample item for management commitment was “Top management takes a leading role in promoting sustainability across the organization.” Furthermore, the items used to measure the operational performance were adapted from [29]. A sample item for management commitment was “There has been a reduction in the payment of compliance fees.”

Table 1: Reliability Analysis

Construct	Number of items	Cronbach's Alpha
Green Transportation	4	.922
Green Packaging	4	.871
Green Purchasing	4	.834
Reverse Logistics	4	.902
Operational Performance	4	.911
Management Commitment	4	.899
Total	24	.889

4. RESULTS AND DISCUSSION

4.1 Scale Validation

Prior to conducting structural equation modelling (SEM), a rigorous validation process was performed to ensure the reliability and validity of the study. Exploratory factor analysis (EFA) was used to gain comprehensive insight into the structure of the variables and to identify the measurement items that captured the underlying constructs. To assess sample adequacy, both the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity were used. The results indicated that the sample met the required significance level in Bartlett's test ($p < 0.05$) and exhibited a KMO value of 0.638, Approx. Chi-square of 297.534, and a degree of freedom [df] of 302; $p < 0.001$. Factor analysis was performed using Varimax Rotation, which converged after 24 iterations, explaining 69.723% of the total variance in the data. As anticipated, the solution yielded six components, namely GTR, GPK, GPU, RVL, MGC, and OPF. Furthermore, the measurement items were assessed for reliability and all constructs exhibited Cronbach's alpha coefficients above 0.7, confirming their high reliability. The results are presented in Table 1.

This study used maximum likelihood estimation (MLE) to estimate the measurement model (Field, 2009). Green logistics was treated as a second-order construct, represented by GTR, GPK, GPU, and RVL. To ensure convergent validity, the model fit indices, standardized factor loadings (λ), critical ratios (CRs), and average variance extracted (AVE) were assessed. Various model fit indices, including CMIN/DF (χ^2/DF), Goodness of Fit Index (GFI), Adjusted GFI (AGFI), Normed Fit Index (NFI), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA) were used. Appropriate model fit indices are presented in Table 2. All standardized factor loadings for the items exceeded the minimum threshold of 0.6 and exhibited notable statistical significance at $p < 0.001$. Furthermore, the average variances extracted (AVEs) for all measured constructs exceeded the required threshold of 0.5, thereby meeting the necessary criteria for achieving convergent validity, as recommended by [77, 78]. Table 3 shows the results of λ and CR.

Table 2: Measurement model fit index

Fit indices	Measurement model	Recommended values	Sources
$\chi^2/DF=$	2.18	≤ 3.000	[79, 80]
GFI=	.911	> 0.900	
AGFI=	.941	> 0.900	
NFI=	.952	> 0.900	
TLI=	.940	> 0.900	
CFI=	.963	> 0.900	
RMSEA=	.052	< 0.080	

Table 3: Constructs, items, λ and CR

Constructs	Items	λ	CRs
Green transportation	GTR1	.701	–
	GTR2	.724	10.519***
	GTR3	.612	15.146***
	GTR4	.817	13.606***
	GTR5	.625	9.728***
Green packaging	GPK1	.703	–
	GPK2	.719	13.901***
	GPK3	.682	14.072***
	GPK4	.643	10.507***
	GPK5	.673	8.601***
Green purchasing	GPU1	.708	–
	GPU2	.643	12.832***
	GPU3	.603	9.865***
	GPU4	.670	10.225***
Reverse logistics	RVL1	.601	–
	RVL2	.745	10.529***
	RVL3	.712	9.166***
	RVL4	.615	13.646***
	RVL5	.627	8.758***
Operational performance	OPF1	.743	–
	OPF2	.748	9.442***
	OPF3	.652	10.701***
	OPF4	.643	13.057***
Management commitment	MGC1	.831	–
	MGC2	.705	8.840***
	MGC3	.611	9.307***
	MGC4	.704	11.002***

Note: – CR is fixed; *** $p < 0.001$

To ensure discriminant validity, the average variance extracted (AVE) was matched with the squared interconstruct correlations (SICCs). All AVEs exceed

the SICCs, meaning the conditions for discriminant validity were met as recommended by [81]. Findings on discriminant validity are presented in Table 4.

Table 4: AVEs and SICCs

Construct	GTR	GPK	GPU	RVL	OPF	MGC
Green Transportation (GTR)	.714					
Green Packaging (GPK)	.421	.539				
Green Purchasing (GPU)	.418	.431	.689			
Reverse Logistics (RVL)	.402	.352	.407	.701		
Operational Performance (OPF)	.336	.295	.216	.246	.655	
Management Commitment (MGC)	.333	.233	.401	.352	.422	.722

Note: Diagonal elements in bold represent AVEs

Table 5: Hypothesis Testing

	Hypothesized Relationships	SRW	CR	Remark
H1 _a	Green transportation → Operational Performance	.289	8.937***	Supported
H1 _b	Green packaging → Operational Performance	.404	11.374***	Supported
H1 _c	Green purchasing → Operational Performance	.322	10.320***	Supported
H1 _d	Reverse logistics → Operational Performance	.427	8.913***	Supported

Notes: SRW standardized regression weight, CR critical ratio, ** significant at p<0.05, *** at p<0.001

Table 6: Moderated Regression Analysis

Variable	Beta	t-statistic	p value	Remark
Management commitment	.766	6.041	.001	Supported

4.2 Structural Equation Modelling (SEM)

Using the SEM technique, hypothesised relationships (H1a, H1b, H1c, and H1d) were tested in AMOS version 21. The model fit indices demonstrated a satisfactory fit: CMIN/DF = 3.08; GFI =.875; AGFI =.901; NFI =.852; TLI =.944; CFI =.933; and RMSEA =.056. The outcomes of the hypothesis test are presented in Table 5.

The results presented in Table 6 show the moderated regression model. The finding showed that the relationship between green logistics practices, management commitment, and operational performance is statistically significant (t = 6.041, p< 0.001). This implies that management commitment moderates the influence of the adoption of green logistics practices on the operational performance of firms in the Zimbabwean road freight sector.

Table 5 presents the statistically supported results for H1a, H1b, H1c, and H1d. The results in Table 6 and Figure 2 show that H2 is supported, indicating that management commitment can significantly moderate

the influence of the adoption of green logistics practices on the operational performance of firms in the road freight sector. This study demonstrated that green transportation significantly affects the operational performance of firms in the road freight sector in Zimbabwe. According to the study, the use of electric vehicles, biofuels, proper vehicle maintenance, alternative fuels, and driver behavior all have a significant impact on the cost and quality of services provided by these companies. This finding is consistent with the empirical findings of [48], which show that certain driver behaviors, such as faster acceleration and braking and leaving the engine running while the vehicle is stationary, reduce fuel consumption and significantly increase carbon emissions. Additionally, [53] asserted that proper route optimization reduces accidents, breakdowns, oil spillage, and traffic congestion. This study also established that green purchasing significantly influences the operational performance of road freight companies in Zimbabwe. This implies that procuring vehicles that emit lower levels of pollutants and eco-friendly motor spare parts

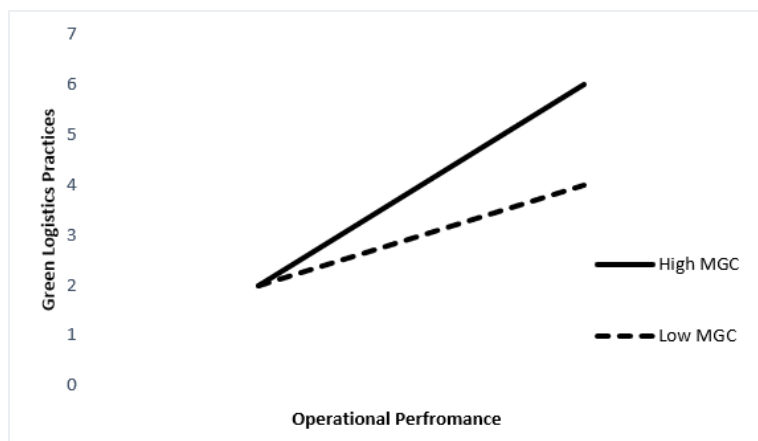


Figure 2: The moderating role of MGC

can effectively reduce their carbon footprint, conserve energy, and lower operating costs. These findings are supported by those obtained by [60] and [57], who highlighted that green purchasing not only reduces costs but also facilitates savings through life cycle assessment and whole-life costing.

Additionally, the study demonstrated that green packaging positively impacts the operational performance of road freight companies in Zimbabwe. This implies that incorporating recycled paper, cardboard, biodegradable plastics, and lightweight materials can effectively decrease the overall weight of the packaging. As a result, this reduction leads to lower fuel consumption and, subsequently, contributes to reduced carbon emissions by road freight firms in Zimbabwe. These findings are consistent with those of [82], who claimed that green packaging allows for the use of lightweight, recyclable, reusable, and biodegradable materials, while avoiding the use of non-ecological materials. Similarly, [83] argues that adopting a sustainability perspective for packaging involves assessing various design alternatives using life cycle assessment. The aim is to mitigate the environmental impact and eco-burden of packaging. In addition, the study concludes that reverse logistics positively influences the operational performance of firms in the road freight sector. This suggests that the ability of firms in the road freight sector to disassemble, repair, or replace defective automobiles significantly improves vehicle performance, thereby reducing the risk of accidents. In line with the findings of [84], this study revealed that reverse logistics can play a pivotal role in ensuring compliance with environmental regulations and legal requirements related to waste management and product disposal. This, in turn, boosts operational efficiency, increases competitiveness, and decreases overall costs. Furthermore, this study established that management commitment moderates the influence of the adoption of green logistics practices on the operational performance of firms in the road freight sector in Zimbabwe.

5. CONCLUSIONS AND IMPLICATIONS

Green logistics have gained prominence, especially in the sub-Saharan region. This research makes a substantial contribution to the understanding of the effect of adopting green logistics practices on operational performance. This study established that GTR, GPK, GPU, and RVL positively influence the operational performance of firms in the road freight sector in Zimbabwe. Furthermore, the study reveals that management commitment plays a moderating role in the relationship between the adoption of green practices and operational performance of firms in the road freight sector in Zimbabwe.

Theoretical implications

There is consensus in the literature that the adoption of green logistics practices influences operational performance. Our findings demonstrate that green transportation has a significant positive effect on the operational performance of companies in the road freight sector in Zimbabwe. This encompasses various practices, such as the use of electric vehicles, biofuels, regular vehicle maintenance, the adoption of alternative fuels, and promoting environmentally responsible driver behavior. These practices not only impact the cost structure of these companies, but also enhance the quality of services they provide. In line with our results, prior research, such as [48], has indicated that specific driver behaviors, such as aggressive acceleration and braking, as well as idling while stationary, contribute to increased fuel consumption and carbon emissions. Additionally, our study highlights that proper route optimization is a key component of green logistics, reducing accidents, breakdowns, oil spillage, and traffic congestion. This finding aligns with the insights presented in [53], which emphasize the pivotal role of route optimization in minimizing negative environmental impacts. The study also reveals that green purchasing significantly influences the operational performance of road freight companies in Zimbabwe. Previous research has shown that green purchasing not only reduces costs, but also results in savings through practices such as life cycle assessment and whole-life costing, as demonstrated by studies such as [60, 57]. In addition, our research establishes that green packaging positively affects the operational performance of road freight companies in Zimbabwe. This is consistent with [82], which suggests that green packaging allows for the use of lightweight, recyclable, reusable, and biodegradable materials, while minimizing the use of non-ecological materials. Moreover, our findings indicate that reverse logistics plays a vital role in enhancing the operational performance of firms in the road freight sector. This corroborates the conclusions drawn in [84], emphasising the importance of reverse logistics in ensuring compliance with environmental regulations and legal requirements related to waste management and product disposal. Furthermore, this study reveals that the extent of management commitment moderates the effect of adopting green logistics practices on operational performance. Given the limited empirical evidence on this relationship, the findings make a significant contribution to the green logistics literature.

Managerial Implications

Firms in the road freight sector should identify opportunities for shipment consolidation to improve their route planning. Shipment consolidation allows goods to be transported using fewer vehicles, resulting in lower emissions and smaller carbon footprints. In addition, firms should invest in modern technologies such as global positioning systems (GPS), telematics,

and route optimization software to improve the collection of green data, reduce fuel consumption, and increase vehicle utilization. Additionally, the government should provide incentives such as tax breaks or subsidies to encourage the use of fuel-efficient vehicles and hasten the implementation of green logistics practices in the road freight sector. Moreover, the government should implement carbon pricing mechanisms to encourage firms in the road freight business to reduce their carbon footprints and adopt environmentally friendly logistics practices. Furthermore, road freight companies should pursue ISO 14001 certification as a tangible demonstration of their commitment to sustainability and environmental responsibility.

Implications for future research

It is worth noting that this study was confined to the road freight sector in Zimbabwe, which makes it difficult to generalize its findings. Therefore, future studies of this nature should be conducted in other sectors of the economy and in different countries to address the generalization issue. Additionally, incorporating various green logistics practices could lead to more intriguing results. Furthermore, it is also suggested that future studies should explore the inclusion of other mediating variables to gain a deeper understanding of the relationships between variables.

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