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RESEARCH ARTICLE:

Extending Green Supply Chain Management to the Mining Sector in South Africa: Implications for Corporate Performance

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Abstract

The South African mining sector faces numerous challenges that limit the performance of firms, chief among them environmental management, labour, and operational issues. An important research gap exists on how the adoption of green supply chain management (GSCM) can contribute to the mitigation of some of these challenges. This study investigates the connection between GSCM, employee satisfaction, operational and relational efficiency, and enterprise performance in the mining sector in South Africa. The study employed a quantitative method using a cross-sectional survey design. A structured research questionnaire was used to collect data from supply chain professionals at two leading mining firms based in the North-West Province, South Africa. The collected data were analysed using a structural equation modelling procedure based on the partial least squares technique. The study reveals the positive influence of GSCM on employee job satisfaction, operational efficiency, relational efficiency, and enterprise performance. The study also confirms that relational efficiency and operational efficiency both exert a positive influence on enterprise performance. However, employee job satisfaction exerted no influence on enterprise performance. GSCM itself exerted a direct positive influence on enterprise performance. The application of GSCM in the mining sector should be recognised as part of the solutions to motivating supply chain professionals and stimulating important internal and external efficiencies, leading to the enhanced performance of the firm.

Keywords: *South African mining sector; green supply chain management (GSCM); employee job satisfaction; operational efficiency; rational efficiency; enterprise performance*

Introduction

The South African mining sector is an important economic sector (Minerals Council South Africa, 2020). It contributed to about 7.3 percent of the country's gross domestic product (GDP) in 2018, translating to a direct contribution of R350.8 billion in that year (Chamber of Mines, 2018). Furthermore, the mining sector has a considerable number of firms and generates substantial revenue. According to a report by the Minerals Council of South Africa (2021), the sector employed 458 954 people and contributed R78.1 in taxes in 2021. These contributions underscore the strategic importance and critical role of this sector as one of the critical drivers of the country's socio-economic development. According to a preliminary report from Statistics South Africa (2021), mineral production in the country increased by 21.9 percent in May 2021 compared to the period ending in May 2020. However, despite the presented evidence of the sector's significance to the South African economy, it still faces many challenges that limit its performance.

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Mining operations are regarded as strategic and essential industrial activities that depend on extraction, transportation and non-renewable natural resources, causing several environmental interactions (Beavon, 2019; Govindan, Muduli, Devika and Barve, 2016). The dependence of mining operations on the environment has resulted in grave concerns about the negative impacts of these activities on air, water, land, soil quality, and vegetation, including forest ecosystems, human health, and habitation. Environmental sustainability is one of those challenges driving firms to develop internal green activities (Jacob, Kraude and Narayanan, 2016; Joshua and Bekun, 2020). The South African mining sector has encountered operational challenges related to the COVID-19 pandemic. It is, therefore, vital for the sector to mitigate these challenges and improve its overall productivity.

Environmental issues from the extractive industries and especially mining is prevalent and harmful. An effective way to manage these pernicious environmental problems is through organisational practices that include broader supply chain management (SCM). Green supply chain practices and their role in mining sector strategy and operations have not been comprehensively addressed (Kusi-Sarpong, Sarkis and Wang, 2016; Agyabeng-Mensah, Ahenkorah, Afum, Agyemang, Agnikpe and Rogers, 2020). According to Shafique, Asghar and Rahman (2017), protecting the environment has become an essential concern to most customers and regulatory authorities in every country, which explains why environmental protection has become the bone of contention among different organisations. Green supply chain management (GSCM) is fully-fledged and covers the stages of the product lifecycle that mainly focuses on green purchasing, green manufacturing, green logistics, investment recovery and cooperation with customers. By implementing GSCM practices, organisations hannacan achieve superior performance, focusing on environmental, social, economic and operational performance (Cousins, Lawson, Petersen and Fugate, 2019).

This study investigates the connection between GSCM and enterprise performance in the South African mining sector in the North-West province. Recently, the South African mining sector has been beset by problems in industrial relations, which have persistently reduced competitiveness and deterred foreign investment (Marketline, 2018). In May 2016, a South African High Court ruled that people who contracted silicosis and tuberculosis due to unsafe conditions at mines could join in a class-action lawsuit against mining firms for compensation (Brickhill, 2021; Goldblatt and Rai, 2018). The resurgence of mining-related diseases implies that mining firms will face increased regulatory activity, new and tighter dust limits, operational changes and increased corporate liability (Ibid). Recently, compensation packages were agreed with complainants following the 2012 shooting of 34 miners involved in a wildcat strike in Marikana (Ibid). Therefore, this study presupposes that improving GSCM practices will lead to superior enterprise performance in the mining sector, a solution to the sector's challenges.

Several studies on GSCM in the mining sector have been conducted in South Africa (e.g., Senkoto, 2019; Bag, 2018; Pooe and Mhelembe, 2014; Mbedzi, Van der Poll and Van der Poll, 2018; Bvuma, 2013). However, a gap remains in the mining sector, especially concerning the impact of such practices on the performance of individual firms. The study is intended to address this gap. This article is structured as follows: the next section presents a brief review of the literature and the development of hypotheses to be tested, followed by the presentation of the conceptual model. Thereafter, the research methodology is presented, succeeded by the research results and discussion. The closing sections of the article present the conclusion and managerial implications as well as the limitations and future research directions.

Literature Review

The mining sector in South Africa

The South African mining sector is one of the prominent contributors to the country's economy (Khubana, Rootman and Smith, 2022; Ackers and Grobbelaar, 2021; Chamber of Mines, 2017). The sector's gross domestic product (GDP) input also increased from R353.2 billion in 2020 to R480.9 billion in 2021 (Mineral Council of South Africa, 2021).

Endowed with abundant natural resources, South Africa is the world's largest producer and exporter of gold, chromium and platinum and 90 percent of the world's global platinum mineral resources are estimated to be in South Africa's bushveld complex (Pwc South Africa, 2020; Kotze and Rossouw, 2017).

Green supply chain management

GSCM may be perceived as a systematic and integrated approach that can help firms develop win-win strategies resulting in profit and market share objectives achievement and environmental efficiency (Wong, Wong and Boon-itt, 2015). GSCM intends to minimise waste and recognise the disproportionate environmental impact of the supply chain processes within the industrial system; hence, it helps to conserve energy and prevent the dissipation of dangerous materials into the environment. Abdel-Baset *et al.* (2019) echo this point by advancing that GSCM has become an emerging environmental practice for manufacturers to improve the environmental image and gain economic benefit. Chin *et al.* (2015) assert that the overall benefits of GSCM are environmental sustainability and financial performance. Mining activities, by their nature, are harmful to the environment(Hanna and Arnold, 2022), making GSCM a topical issue in this sector. This leads to the following hypotheses;

H_1: GSCM practices exert a positive and significant influence on relational efficiency within the mining industry

H_2: GSCM practices exert a positive and significant influence on operational efficiency within the mining industry

H_3: GSCM practices exert a positive and significant influence on employee job satisfaction within the mining industry

Relational efficiency

Relational efficiency refers to the ability of firms to increase transparency and openness in the business process, working jointly with buyers so that suppliers can build trust and credibility in the relationship with buyers (Lee, Tae Kim and Choi, 2012; Zacharia, Nix and Lusch, 2009). According to Dyer and Singh (2012), the relational view theory suggests that a firm's competitive advantage depends on the network of relationships in which the firm is embedded. It has been established that improved communication channels, sound collaborative engagement, and trust across an organisation's value chain are some drivers of operational performance (Fernando *et al.,* 2020; Valencia-Cabrera *et al.,* 2017). In addition, joint efforts between buyers and suppliers to increase efficiency and pursue high-quality management goals may strengthen their relationship, leading to a unique, non-imitable exchange of resources and knowledge (Kotzé, 2017; Turkmen, 2013). The following hypothesis is proposed;

H_4: Relational efficiency exerts a positive and significant influence on enterprise performance in the mining sector in South Africa

Operational efficiency

Operational efficiency refers to the abilities of supplier organisations firms to minimise cycle time and costs, enhance product quality, and create more significant value for customers. (Rusinko, 2007). From a supply chain perspective, operational efficiency has been well-studied, with Qrunfleh and Tarafdar (2014) deducing that information systems strategy improves internal and inter-organisational operational efficiencies through applications that enable day-to-day coordination internally among the firm's departments and externally with customers and suppliers. Brane *et al.* (2017) highlight that the personal development of their employees increased their skills and job satisfaction and improved their operational efficiency. Operational efficiency commitment to environmental friendliness is vital in determining firm performance based on market value. Voulgaris and Lemonakis (2014) and Bhardwaj and Agrawal (2020) suggest that

operational efficiency as a strategy has become key to improving a firm's performance and competitive ability, reducing production costs and increasing the firm value. The study hypothesises that;

Employee job satisfaction

Employee job satisfaction is defined as the feeling that employees have about their jobs relating to the relationship with their supervisors and working environment which could lead to better performance outcomes (Lee *et al.,* 2012; Cusumano, Kahl and Suarez, 2008) . It measures the degree of employee pleasure that leads to better task performance (Kim, 2010). Its relevance and criticality cannot be understated, given its role in ensuring that firms' workforces perform their duties optimally. According to several empirical investigations, its practical implementation depends on various aspects. Van Der Walt and De Klerk (2014) suggest that job satisfaction is influenced by an individual's disposition to be happy regardless of the work situation and what an employee brings to the organisation, such as personality traits. This viewpoint is supported by Van der Walt *et al.* (2016) and Badrianto and Ekhsan (2020), who mention that employees that find their work interesting are likely to be more satisfied and motivated to perform their daily tasks and duties adequately than those who are not satisfied with their jobs. As such, where employees perform standardised work, which is common in the mining sector, it is necessary to apply value-enhancing practices such as job rotation, enrichment, and enlargement to ensure that such employees are satisfied. The following hypothesis is proposed;

H_5: Operational efficiency exerts a positive and significant influence on enterprise performance in the mining sector in South Africa.

Enterprise performance

Enterprise performance is defined as the summation of economic, environmental, operational, and social performance within a business organisation (Geng, Mansouri and Aktas, 2017; Mitra and Datta, 2014). Green, Zelbst, Meacham and Bhadauria (2012) define it as a multidimensional construct, with dimensions such as financial or non-financial performance identified as factors that encapsulate it. In their study, Abdul, Khan and Qianli (2017) established a correlation between the implementation of green information systems and firm performance. In their findings, Godsell, Birtwistle, Hoek Van and Godsell (2015) suggest that Sales and Operations (SandOP) is the most critical process to enable a business to optimise its profitability. Implementing GSCM practices will allow firms to bear institutional pressures, enabling them to get a competitive advantage through corporate social responsibility of environmental protection (Shafique *et al.,* 2017). Thus, businesses should strive to optimise their core resources to reach this objective. Implementing GSCM practices will allow firms to bear institutional pressures, enabling them to get a competitive advantage through corporate social responsibility of environmental protection (Shafique *et al.,* 2017). Thus, businesses should strive to optimise their core resources to reach this objective. The following hypothesis is formulated;

H_7: GSCM exerts a positive and significant influence on enterprise performance in the mining sector in South Africa

Conceptual model and hypotheses development

In their study in the electronics sector in Korea, Lee, Kim and Choi (2012) found relationships between GSCM implementation, employee job satisfaction (EJS), operational efficiency, rational efficiency, and enterprise performance. The same conceptual model is presented in Figure 1 and tested within the mining sector context in South Africa's North-West Province. GSCM is the predictor variable, while employee job satisfaction, operational efficiency and relational efficiency are the mediating variables. The outcome variable is in the form of enterprise performance.

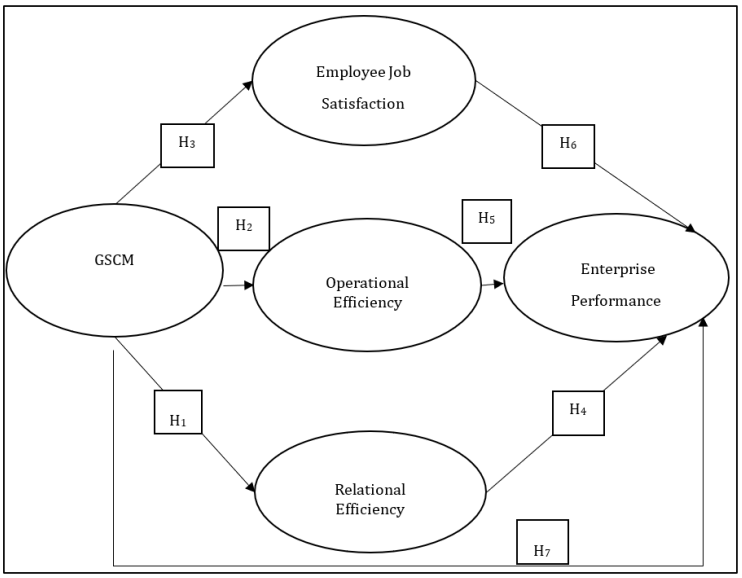

Figure1: Conceptual framework (Lee *et al.* 2012)

Methodology

The study is anchored on the positivism paradigm, supported by the quantitative method, in which numeric data were applied to measure the constructs of interest and objectively determine their causal direct and indirect linkages (Leedy and Ormrod, 2015; Blumberg, Cooper and Schindle, 2014). The study also used a cross-sectional survey design, in which a structured research questionnaire was used to collect data from the selected respondents in a single snapshot of time. The target population for the study consisted of supply chain professionals, namely managers (senior, middle and line), supervisors, specialists, superintendents, and clerical employees, all operating in the entire supply chain department of Lonmin and Impala Platinum Mines in Rustenburg, in the North-West province of South Africa. The sample size in this study was based on a recommendation by Hair, Ringle and Sarstedt (2011) that the minimum sample size in a study that used SMART partial least squares (PLS) must be at least 10 times the number of links (paths) or hypotheses being tested in that study. This being the case, the current research tested seven paths (connections) between various constructs, implying that the minimum acceptable sample size is 70. This further suggests that the final sample size of 187 used in this study is acceptable, given that the data analysis was based on the PLS technique.

Data for the main survey were collected using emails in which respondents provided the researcher with their email addresses after agreeing to participate in the survey. A physical distribution could not be performed due to restrictions imposed by the government to mitigate the devastating effects of the COVID-19 pandemic. The process was undertaken between July and September 2020. The measurement scales used in the study were operationalised from previous studies. GSCM was measured using seven questions derived from Matos and Hall (2007), Rusinko (2007) and Zhu, Geng and Lai (2010). Employee job satisfaction used five questions adapted from Homburg and Stock (2004); Zhou, Ki, Zhou and Su (2008). Operational efficiency was measured using five questions adapted from Rusinko (2007), Paulraj, Lado and Chen (2008) and Zacharia *et al.* (2009). Besides, rational efficiency was assessed through six-questions adapted from Zacharia *et al.* (2009). Lastly, enterprise performance used five questions derived from Zacharia *et al.* (2009). This instrument uses subjective measures of enterprise performance based on aspects such as competitive position, profitability, customer satisfaction, supplier performance and productivity levels. The response options provided in section B of the questionnaire are based on a Likert scale anchored by 1=strongly disagree to 5=strongly agree.

Data Analysis

Data analysis was performed using a structural equation modelling (SEM) procedure based on the partial least squares (PLS) technique. SMART PLS 3.0 software was employed in the data analysis.

Demographic profile of respondents

The results derived from the gender of the respondents indicate that 56 percent (n=104) were males and 44 percent (n=83) were females. Regarding the age groups of respondents, the largest number of respondents were aged between 26 and 33 years (33.7%; n=67). Moreover, the racial distribution shows that the majority (52.9%; n=99) of the respondents were black. Lastly, regarding the employment position of the respondents, the results indicated that most respondents (59%; n=110) were managers and SCM specialists in the sampled mining firms in the North-West province.

Scale descriptive statistics

The descriptive statistics of the research constructs are presented in Table 1, showing the mean scores, standard deviations and the measures of data normality. The mean values were intended to measure the levels of the constructs in the mining industry.

Table 1: Descriptive statistics of the research constructs

Construct	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
GSCM	187	3.6723	.82271	-1.157	.291	1.033	.574
EJS	187	3.5941	.74351	-.510	.291	.476	.574
OE	187	3.9176	.54880	-.366	.291	-.746	.574
RE	187	3.8995	.72284	-.581	.291	-.153	.574
EP	187	4.0647	.69835	-.791	.291	-.014	.574
Scale: 1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree GSCM= Green supply chain management; EJS= Employee job satisfaction; OE= Operational efficiency; RE= Relational efficiency; EP= Enterprise performance							

Table 1 shows that respondents were in agreement with the items on the Lickert scale, with a mean ranging between 3.67 and 4.06. By implication, respondents were generally satisfied with the level of implementation of GSCM in their firms. They were also satisfied with their own levels of job satisfaction and the levels of operational and relational efficiency, and their firms' performance. Skewness and Kurtosis statistics fell within the prescribed ranges (-2 to +2) for Skewness and (-3 to +3) for Kurtosis (Kim and White, 2004; Bali, Mo and Tang, 2008; Mardia, 1974), indicating that the data were normally distributed.

Scale accuracy assessment

Structural equation modelling (SEM) is used to test the study's hypotheses. SEM refers to a method to ascertain the direct or indirect causal associations between research constructs (Kelloway ,1995). In applying the SEM technique, two phases are employed. The first is to test for scale accuracy, followed by testing the hypothesis using a method known as path analysis. This study considered two critical parameters in testing for scale accuracy: validity and reliability. The results of the scale accuracy assessment are indicated in Table 2.

Table 2: Scale accuracy

Research constructs		Factor Loadings	Cronbach Alpha α Value	C.R. value	Rho A	AVE
GSCM	GSCM1	0.741	0.874	0.902	0.894	0.570
	GSCM2	0.688				
	GSCM3	0.705				
	GSCM4	0.809				

	GSCM5	0.778				
	GSCM6	0.676				
	GSCM7	0.868				
EJS	EJS1	0.721	0.803	0.861	0.877	0.556
	EJS2	0.639				
	EJS3	0.788				
	EJS4	0.700				
	EJS5	0.861				
OE	OE2	0.735	0.694	0.812	0.685	0.522
	OE3	0.768				
	OE4	0.586				
	OE5	0.783				
RE	RE1	0.713	0.866	0.900	0.872	0.601
	RE2	0.838				
	RE3	0.773				
	RE4	0.739				
	RE5	0.797				
	RE6	0.785				
EP	EP1	0.802	0.870	0.906	0.879	0.659
	EP2	0.746				
	EP3	0.797				
	EP4	0.836				
	EP5	0.871				
GSCM= Green supply chain management; EJS= Employee job satisfaction; OE= Operational efficiency; RE= Relational efficiency; EP= Enterprise performance						

Reliability of the measurements scales

Reliability is the consistency with which a measuring instrument yields a particular, consistent result when the entity being measured has not changed (Leedy and Ormrod, 2015). This study measured reliability using the Cronbach's alpha coefficient, the composite reliability (CR) and the Rho A statistic. As indicated in Table 2, Cronbach alphas, CR, and Rho_A values for all measurement scales were higher than the prescribed 0.7 minimum threshold.

Validity of the measurement scales

Validity refers to the consistency and accuracy of a study's measurement instrument in different contexts or settings (Roberts and Priest, 2006; Rourke and Anderson, 2004). To test for convergent validity, factor loadings were considered. A minimum value of 0.5 was considered an indicator of scale item convergence, as recommended by Cheung and Wang (2017). As highlighted in Table 2, item factor loadings for all scales were higher than 0.5, ranging from 0.586 to 0.871, confirming that the scales had acceptable convergent validity.

The study also tested for discriminant validity, using the Fornell-Larcker criterion was applied to test whether those items that were not related were not correlated in the study. According to Fornell and Larcker (1981), the square root of a construct must be higher than its highest correlation with other constructs. As indicated in Table 3, this rule was satisfied, indicating that there was sufficient discriminant validity in this study.

Table 3: Discriminant validity

Construct	**EJS**	**EP**	**GSCM**	**OE**	**RE**
EJS	0.746				
EP	0.515	0.812			
GSCM	0.359	0.591	0.755		
OE	0.505	0.649	0.494	0.723	
RE	0.504	0.805	0.455	0.543	0.775

GSCM= Green supply chain management; EJS= Employee job satisfaction; OE= Operational efficiency; RE= Relational efficiency; EP= Enterprise performance

Hypotheses tests

Hypotheses were tested using the PLS technique. The results are presented in the structural model in Figure 2.

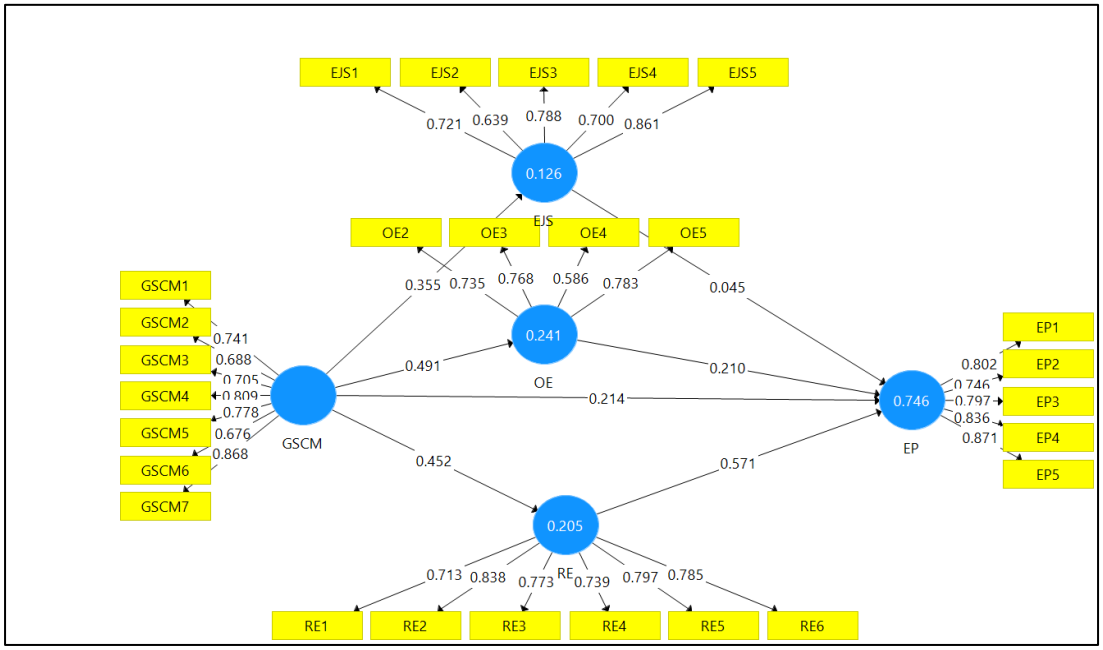

Figure 2: Structural model

The structural model presents the path coefficients between the constructs and the factor loadings between the constructs and the items. The r-square values are placed within each construct.

Results of hypotheses tests

The seven relationships hypothesised in this study's conceptual model (Figure 1) were tested accordingly, employing SEM. The results, which show the beta coefficient values, the corresponding T and P-values and the outcome of each hypothesised relationship, are provided in Table 4.

Table 4: Results of hypotheses testing

Relationship	Hypothesis	Path Coefficient	T value	P-value	Outcome
GSCM vs RE	H_1	.452	3.071	.002	Significant and supported
GSCM vs OE	H_2	.491	4.634	.000	Significant and supported.
GSCM vs EJS	H_3	.355	4.042	.000	Significant and supported
RE vs EP	H_4	.571	5.816	.000	Significant and supported
OE vs EP	H_5	.210	2.453	.015	Significant and supported
EJS vs EP	H_6	.045	0.658	.511	Insignificant and not supported
GSCM vs EP	H_7	.214	2.316	.021	Significant and supported
GSCM= Green supply chain management; EJS= Employee job satisfaction; OE= Operational efficiency; RE= Relational efficiency; EP= Enterprise performance					

The results (Table 4) reveal that except for H_6, which initially suggested an insignificant relationship between EJS and EP, the other six hypotheses (H_1, H_2, H_3, H_4, H_5 and H_7) were supported. The highest path coefficient (β =0.571) was observed between RE and EP.

Discussion of Results

The first hypothesis indicated that GSCM practices exert a significant positive influence on RE in the mining sector in South Africa. H_1 was supported (β = 0. 452; t= 3.071; p= 0.002). This result supports the relevance of GSCM practices as a strategic driver to mining firms' relationships with their strategic constituencies. The second hypothesis (H_2), pertaining to a positive and significant relationship between GSCM and operational efficiency, was also supported (β = 0. 491; t=4.634; p = 0.000). It confirms the role that GSCM plays as a facilitator of OE in mining firms. Hypothesis three (H_3) was supported (β = 0.355; t=4.042; p = 0.000), validating the critical nexus existing between GSCM implementation and EJS. The study results suggest that the implementation of GSCM practices improves the fluency of strategic relationships, operational processes and job satisfaction in South African mining firms.

Hypothesis four (H_4) is supported (β = 0.571; t=5.816; p =0.000), which shows that sound relational efficiency of operational activities leads to improved performance. Hypothesis 5 (H5) is also confirmed (β = 0.210; t=2.453; p = 0.015), which indicates that efficient operational activities increase performance. Consistently, studies by Agyabeng-Mensah *et al.* (2020) and Ramırez *et al.* (2021) confirm the existence of positive relationships between RE, OE and EP. However, contrary to the previous hypotheses, H_6 is unsupported (β = 0. 045; t=0.658; p =0. 511). This result implies that in the context of this investigation, EJS exerts no influence on EP. .

The final hypothesis (H_7) is supported (β = 0. 214; t= 2.316; p = 0.021), which shows that GSCM is a determinant of EP. This result parallels the conclusions of a recent study by Habib *et al.* (2021), who found that green practices have a positive impact on organisational performance through their role in reducing production costs and lessening energy consumption. Hence, improvement of mining firm performance hinges, among other things, on adopting and effectively implementing GSCM practices.

Conclusion

This study aimed to examine GSCM practices and their influence on the performance of selected firms within the South African mining sector. The study reveals positive relationships between GSCM and three factors: employee job satisfaction, operational efficiency, relational efficiency and enterprise performance. The study also confirms that RE and OE both influence EP. However, EJS exerted no influence on EP. GSCM itself exerted a significant positive impact on EP. The study is vital in that it applied a conceptual framework involving these factors in a new South African context, thereby creating a knowledge base for similar studies. The study has managerial implications. Mining organisations should adopt GSCM practices to improve the effectiveness of operations in the mining sector. Supply chain professionals need to receive training on the importance of GSCM in their sector and how to implement such activities. It is also necessary for the government of South Africa to emphasise the importance of ecological concerns and further implement environmentally friendly policies and practices within the mining sector.

This study was restricted to two mining firms in the North-West province, South Africa and its sample size was limited to 187 respondents. Caution must therefore be exercised in generalising the results to other mining sector contexts. Future studies can be extended to mining firms in other South African provinces to ensure that the results are more representative of the mining sector in the country. Because the study tested GSCM as a unidimensional factor, specific GSCM practices such as green procurement, green operations, green training, and green distribution, among others, should be considered in future research. Similar studies can be undertaken in other sectors of the economy, which will provide a basis for comparison with the mining sector.

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