“Influence of environmental management accounting practices on the environmental sustainability of South African cement and mining companies”

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INFLUENCE OF ENVIRONMENTAL MANAGEMENT ACCOUNTING PRACTICES ON THE ENVIRONMENTAL SUSTAINABILITY OF SOUTH AFRICAN CEMENT AND MINING COMPANIES

Abstract

Most companies in emerging economies need to be more conscious of environmental initiatives such as environmental management accounting practices (EMAP) that can effectively improve environmental sustainability. Therefore, this study investigates the effect of EMAP on the environmental sustainability of listed South African cement and mining companies. To achieve the aim of the study, 45 Johannesburg Stock Exchange-listed cement and mining companies were sampled based on data extracted from the annual integrated reports, financial statements, environmental and sustainability reports from 2012 to 2021. IBM SPSS Statistics 24 was used to analyze the relationship between EMAP and environmental sustainability. The results show that two environmental sustainability proxies, water consumption and recycled water, are significantly and positively related to EMAP. However, carbon emissions ($p < .061$) insignificantly influence environmental sustainability. This suggests that some EMAP used by the sampled companies are inadequate to amplify environmental sustainability. The paper is essential to provide empirical evidence that managers of the cement and mining companies in South Africa need to devise better and new EMAP to reduce carbon emissions.

Keywords environmental sustainability, environmental management accounting practices, cement and mining companies, South Africa, sustainability

JEL Classification M41, Q01, Q56

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INTRODUCTION

Globally, business activities have had a considerable impact on environmental sustainability. This has been partially attributed to the fact that most corporations are unaware of their environmental initiatives' impact on environmental performance. As a result, poor environmental sustainability remains the order of the day, particularly in emerging economies such as South Africa. South Africa remains among the countries with the highest poor environmental sustainability (Dzomonda & Fatoki, 2021). This calls for practical actions to lessen the poor environmental sustainability engulfing South Africa.

To overcome the poor environmental performance of the corporate sector, global governments have introduced interventions to assist the corporate sector in reducing negative environmental impacts. These interventions have been termed environmental management accounting practices (EMAP) in literature. For example, in South Africa, the introduction of the King Code III and IV was intended to lessen the environmental impacts of companies through extensive environmen-

tal information disclosure. The literature confirms that the main purpose of introducing various EMAP is to improve environmental performance (Miklosik & Evans, 2021). Despite this, extant literature and corporations have focused less on understanding the actual effect of environmental initiatives such as EMAP on environmental sustainability (Wang et al., 2020). Instead, the literature has focused much on how EMAP influence financial sustainability (Agyemang et al., 2021).

1. LITERATURE REVIEW AND HYPOTHESES

Environmental sustainability has been defined as "responsible interaction with the environment to avoid depletion or degradation of natural resources and allow for long-term environmental quality" (Kumar & Bhatia, 2021). However, scholars have argued that ignoring environmental sustainability issues has some adverse effects on corporate performance (Agyemang et al., 2021; Bananuka et al., 2021; Christine et al., 2019). For instance, IFAC (2005) and Earnhart and Lizal (2010) reported that ignoring environmental costs from production processes influences financial performance as costs are either overstated or understated. This signifies the importance of proper environmental governance. In addition, ignoring environmental sustainability culminates in a high risk of low production levels due to the absence of natural raw materials and resources in the long run (UN, 2001; Ekundayo & Odhigu, 2021). In this regard, Fuadah et al. (2021) stressed that poor environmental performance will push the corporate sector's production performance and profitability to an adverse state due to the limited availability of natural resources.

The definition of EMAP in the literature differs among scholars. Ismail et al. (2014, p. 76) define EMAP as "a tool that assists in improving environmental performance and environmental information approach." At the same time, some scholars use EMAP in the context of environmental initiatives adopted by a company (Klassen & McLaughlin, 1996). The absence of an unequivocal and mutual definition of EMAP influences understanding of its antecedents and consequences. Sari et al. (2021) argue that this creates a critical challenge because "as long as different definitions are used, empirical results cannot reliably be compared."

Mungai et al. (2020) used waste management as an environmental performance construct. The study observed a direct link between the environmental management system and waste management. This suggests that adopting ISO 14001 increases waste management. To echo this, Fei-Baffoe et al. (2013) and Muh. Halis and Min. Halis (2016) disclosed that environmental management systems application is positively connected with environmental performance. In contrast, Tung et al. (2014) found that ISO 14001 is of no significant impact on environmental performance in Australia. Gomez and Rodriguez (2011), comparing certified and non-certified companies, found that ISO 14001 certification is of no importance in reducing a company's pollution levels. However, Mungai et al. (2020) applied questionnaires implying that findings are somehow based on respondents' subjective opinions and knowledge. This may be subjected to bias.

Evidence submitted by Famiyeh et al. (2018) show that EMAP adopted by a sample of 17 companies in Ghana have a strong positive impact on the cost, quality, delivery, and flexibility performance of companies. This result appears to be in line with the findings of Voinea et al. (2020) and Sroufe (2003), with specific reference to the adoption of EMP and its capacity to minimize cost (Porter & van der Linde, 1995; Kumar et al., 2012). In addition, Famiyeh et al. (2018) disclosed that EMAP applied by the sampled companies has a positive association with environmental performance. The study empirically observed that the connection between EMAP and environmental performance is mediated by competitive operational capability. That is to say, spending on EMAP enhances the total environmental performance of companies owing to EMAP enhancing the competitive business performance of companies. Furthermore, Famiyeh et al. (2018) argued that current studies in developing countries need more attention to an empirical examination of the association between EMAP and the environmental performance of companies.

This study focuses on the effect of EMAP on the environmental sustainability of JSE-listed cement companies. Furthermore, this study adopts an ob-

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jective measurement of environmental sustainability from the annual integrated reports, standalone environmental and sustainability reports covering 2010–2021. Famiyeh et al.'s (2018) study was based on surveys, but they are perceived to be biased since it is grounded on the researchers' and informants' personal subjective views (Mokhtar et al., 2016). Balabanis et al. (1998) noted that the credibility of the ratings is very much subjective and is contingent not only on the correctness of information offered to informants but also on their knowledge.

In support of Fuzi et al. (2019), Ong et al. (2020) studied 69 Malaysian ISO 14001 certified manufacturing companies using environmental management system (EMS) to observe a statistically non-significant link between environmental management accounting (EMA) and environmental performance. In order to determine the relationship between EMA and environmental performance, the study postulated that the lack of relationship stems from EMA being in its infancy stage in Malaysia. This demonstrates that owing to EMA being in its initial stages, in some cases, its efficiency in promoting sustainability is limited. Ong et al. (2020) used a questionnaire-based survey to collect data from participants. With limited knowledge of EMA, participants are forced to submit subjective information that may be irrelevant to EMA. According to Montabon et al. (2007), this affects the accuracy of the results, as respondents have to rely on their EMA-discounted opinions to answer questions. In addition, Ong et al. (2020) adapted environmental and financial items from Burrit et al. (2002) and Henri and Journeault (2010), respectively. The study's findings suggest that EMAP had nothing to do with environmental improvements, even when used in conjunction with EMS. This is in contrast to Mokhtar et al. (2016) first-hand finding that companies using EMS are more likely to implement EMA.

Additionally, Ong et al.'s (2020) findings are opposite to Fuzi et al.'s (2019) field observation that EMA has a positive relationship with environmental performance only when moderated by EMS. The absence of a "direct" positive association between EMA and environmental performance calls for companies to look for measures to overturn the "no positive relationship" result. Ong et al. (2020) attributed the lack of statistical nexus between EMA and environmental sustainability to the absence of EMA guidance and training, as companies cannot gather and assess environmentally related data. Moreover, this study considers the lack of a relationship between EMA and environmental performance as suggesting that purposes besides environmental performance enhancement may motivate EMA implementation. The main limitation of Ong et al.'s (2020) study is being based on respondents' subjective perceptions; therefore, the study lacks objectivity.

Mahomed and Jamil (2018), investigating EMA impacts on the environmental performance of 350 SMEs in Malaysia, found that EMAP positively influence environmental performance. Key to their findings is that EMA application includes financial outflows in the form of costs such as cleaner production and environmental expenditure. However, Mahomed and Jamil (2018) used questionnaires to collect data from respondents. As such, their study relied on the subjectivity of SME managers, therefore, lacks objectivity. Furthermore, even though the study acknowledges that EMAP elevate environmental sustainability, it is arguable that it is difficult to get valid objective results from SMEs on EMA in developing countries such as Malaysia due to the absence of proper systems to have documented information.

Pratiwi et al. (2020) studied the bond between EMAP and environmental sustainability. Using panel data, they hypothesized a positive relationship while studying 20 Indonesian companies in mining, agriculture, construction and construction materials, energy, and textile from 2014 to 2018. Based on the research's results, the high eco-efficiency rate shows little energy usage. This is because low consumption of energy positively influences environmental activities (Singh et al., 2016). The empirical findings are supported by Nikolaou and Matrakoukas (2016) and Solovida and Latan (2017). While the basis of the claim is valid, it needs to be revised in its reasoning that a fall in energy usage is attributed to eco-efficiency without considering the production levels of the period under review. A low production level will, in most cases, lead to a decline in energy usage (UN, 2017).

Likewise, Appannan et al. (2020) examined the association between EMA and environmental sustainability and revealed a positive association. The results are based on questionnaires distributed to 145 ISO 4001 certified Malaysian companies. The study found the same relationship as established by Fuzi et al. (2019) between EMAP and environmental performance moderated by EMS after applying structural equation modeling to analyze the data. This outcome shows that EMS is critical in EMA promoting environmental issues. In this view, investment in both EMS and EMA is vital for companies to reduce environmental challenges. According to Appannan et al. (2020), EMA is a component of EMS. The purpose of EMA is to address environmental management issues that companies face. Therefore, EMA cannot be separated from the EMS of the company since a positive relationship between EMA and EMS strengthens the idea of EMA being a segment of EMS.

Voinea et al. (2020) analyzed the effect of EMS on environmental and financial performance in Brazil's 148 companies spanning an eight-year period. EMS was discovered to be negatively connected with financial and environmental performance; the more EMS is applied in companies, the less their environmental and financial performance is. Voinea et al. (2020) attributed this to harsh environmental regulations and hard disclosure practices. Additionally, the study postulates that failure to control variables such as the number of years companies use EMS contributes to a negative relationship partly because some employees may not have sufficient knowledge and benefits of EMS when it is still new. The EMS' impact on financial performance relates to high environmental management and overhead costs. Applying questionnaires, the study employed a perception-based approach based on managers' views to measure environmental and financial performance based on numerical intervals. The findings were, therefore, criticized for lacking objectivity.

The above debate shows that the link between EMAP and environmental sustainability is limited in Africa and South Africa in particular. Pratiwi et al. (2020) argue that the corporate sector is interested in activities that directly improve financial sustainability. However, a closer analysis reveals that most studies focused on understanding how EMAP can improve financial performance at the expense of environmental performance. Still, no empirical research study has investigated how EMAP affect the environmental sustainability of the cement and mining sector from an emerging economy perspective.

Studying the relationship between EMA and the environmental performance of 10 companies in Ghana, Famiyeh et al. (2018) observed and concluded that a lot of studies have not yet attempted to empirically investigate the connection between EMAP and the environmental performance of companies. Previous literature has neglected the field examination of the two variables of EMAP and environmental sustainability. Internationally, this stance has found support in studies by Le et al. (2019) and Ong et al. (2020), which found that, from an empirical standpoint, not so much has been disclosed on the relationship between EMAP and environmental sustainability. Therefore, empirically, it remains uncertain how EMAP adopted by the South African cement and mining sectors affects their environmental sustainability. As a result, this study aims to scrutinize the nexus between EMAP and environmental sustainability measured by recycled water, water consumption, and carbon emissions from 2010 to 2021 for South African cement and mining companies.

Bearing in mind the above discussions, it is hypothesized that:

H1: There is a significant relationship between EMAP and environmental sustainability proxied by recycled water of cement and mining companies in South Africa.

H2: There is a significant relationship between EMAP and environmental sustainability proxied by water consumption of cement and mining companies in South Africa.

H3: There is a significant relationship between EMAP and environmental sustainability proxied by carbon emissions of cement and mining companies in South Africa.

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2. METHODOLOGY

2.1. Data collection

The study focuses on 12 years from 2010 to 2021, utilizing secondary data only. The data for evaluation were extracted from the annual integrated and environmental and sustainability reports of 45 listed cement and mining companies on the Johannesburg Stock Exchange (JSE). EMAP were measured by environmental audits, environmental training, and energy efficiency. On the other hand, environmental sustainability was proxied by carbon emissions, water consumption, and recycled water.

2.2. Sample, population, and data analysis

The population of the study involves 45 cement and mining companies listed on the JSE as of December 31, 2021. Gay et al. (2009) suggest that if a target population is less than 100 participants or units, it is best to sample the whole population. Consequently, this study used the whole population of 45 listed cement and mining companies.

The data collected for the research were evaluated by multiple regression analysis with the assistance of IBM SPSS Statistics 24.

2.3. Model specification

$$EP = \beta_0 + \beta_1 EMAP_{it} + \\ + \beta_2 Log\_YearsonJSE_{it} + \beta_3 Leverage_{it} + \\ + \beta_4 Log\_Employees_{it} + \beta_5 Debtratio_{it} + \varepsilon_{it}, \quad (1)$$

where, i = 1….N (number of companies); it – 1 = Lagged time period; EP = Environmental performance for each cement and mining company in South Africa proxied by (1) recycled water, (2) water consumption and (3) carbon emission, respectively; β_0 = Model intercept; β_1 = Slope of the value of each $EMAP$; $\beta_{2...5}$ = Slope of each control variable; $\beta_1 EMAP_{it-1}$ = Lagged value of each EMA practice; *Log_YearsonJSE* = Total number of years each cement and mining company is listed on the Johannesburg Stock Exchange (JSE). *Log_Employees* = Total number of permanent employees for each cement and mining company; *Debtratio* = Ratio of long-term debt and total assets; *Leverage* = Leverage ratio; ε_{it} = Statistical disturbance term.

3. RESULTS

The hypotheses framed in this study are tested with multiple linear regression analysis.

3.1. Recycled water (*H1*)

The model summary provides information from running the recycled water regression model (Table 1).

Table 1 displays that the control variables predicted significantly recycled water above the EMAP, R-square .567 and F (4, 535) = 3.873, p < .001. EMAP predicted recycled water levels significantly after confining the influences of the control variables, R-square = .567, *F* (3, 532) = .729, p = .047 (significant). Based on these findings, EMAP appeared to be responsible for the main extra predictive power ahead of what is contributed by the control variables, with 5.9% of the variation in recycled water explained by EMAP.

There is confirmation that the recycled water model has explanatory power (p = .045). Table 2 shows *LogENVIRONTRAIN* (p = .049), *LogENERGYEFF* (p = .041), and *LogENVIRONAUD* (p = .032). Therefore, all the individual EMAP significantly forecasted a measure of recycled water. Table

Table 1. Recycled water: Model summary

Model	R	*R*-square	Adjusted *R*-square	Std. error of the estimate	*R*-square change	Change statistics			Sig. *F* change	Durbin-Watson
						F change	df1	df2		
1	.713[a]	.508	.431	.41231	.508	3.873	4	535	.000	–
2	.753[b]	.567	.526	.40881	.059	.729	3	532	.047	2.461

Note: a – Predictors: (Constant), *LogYearsonJSE, LogEmployees, Debtratio, Leverage*; b – Predictors: (Constant), *LogYearsonJSE, LogEmployees, Debtratio, Leverage, LogEnvironTra, LogEnviroAud, LogEnergyEffe; LogEnvironTra, LogEnviroAud, LogEnergyEffe = EMAP*.

Table 2. Coefficients of a dependent variable: Recycled water

Model	Unstandardized Coefficients		Std. Coefficients	*T*	Sig.	Collinearity Statistics	
	B	Std. error	Beta			Tolerance	VIF
(Constant)	.301	.825	–	.161	.045	–	–
LogENVIRONTRAIN	.132	.141	.662	.661	. 049	.833	1.201
LogENERGYEFF	.043	.432	.291	.532	. 041	.702	1.425
LogENVIRONAUD	.023	.889	.772	.962	.032	.562	1.780
LogYearsonJSE	.091	.443	.554	.747	.613	.513	1.976
LogEmployees	.067	.221	.423	.183	.214	.751	1.331
Debtratio	-.013	.762	.572	.832	.004	.598	1.671
Leverage	.398	.065	–.631	–.662	.301	.502	1.992

2 shows that the three EMAP described a significant percentage of the variance of a measure of environmental sustainability performance measured by recycled water, F (3, 532) = 2022.89 and p = .047. The consequence of this finding is that, for each unit increase in EMAP, for instance, *LogENVIRONTRAIN*, recycled water increases by 0.032 or 3.2%. Therefore, the null hypothesis (*H1*) is not rejected, suggesting a significant relationship between the two constructs. However, all three control variables had no significant relationship with recycled water (*Leverage*, p = .301; *LogYearsonJSE*, p = .613, *LogEmployees*, p = .214), while debt ratio had a significant negative relationship with recycled water (B = –.213, p = .004). This means that reducing debt increases the use of recycled water within the production processes of the cement and mining companies in South Africa.

3.2. Water consumption (*H2*)

Table 3 indicates the control variables forecasted significantly beyond the EMAP, R-square = .504, adjusted R-square = .441, F (4, 535) = 2.016, and p < .001. EMAP forecasted water consumption significantly after disregarding the influences of the control variables, R-square change = .048, F (3, 532) = 1.021, and p = .049. Table 3 shows the R-square of .552, indicating that EMAP accounts for a 55.2% contribution to the water consumption of cement and mining companies in South Africa. This means a fairly strong relationship between water consumption and EMAP. The adjusted R-square shows that model developed has 47.3% predictability suggesting that the model is satisfactory for further evaluation. This suggests that a unit change in water consumption is described up to 0.473 by a change in EMAP (*LogEnvironTra*, *LogEnviroAud*, and *LogEnergyEffe*). It also highlights that 52.7% of the variation remains unexplained; therefore, including other independent variables may improve the fit of the model.

Table 4 indicates the power of the association, that is, the significance of the variable in the water consumption model and the level with which it affects the dependent variable. This is critical to conduct hypothesis testing for the investigation.

Table 4 showed that *LogENVIRONTRAIN* (B = .521, p = .042) and *LogENVIRONAUD* (B = .681, p = .047) were significant in predicting the environmental sustainability performance operationalized by water consumption. This denotes that a decrease in *LogENVIRONTRAIN* and *LogENVIRONAUD* increases water consumption. In opposition, *LogENERGYEFF* (p = .067) had no significant capacity to forecast water consumption. Therefore, the null hypothesis (*H2*) is not rejected.

Table 3. Water consumption: Model summary

Model	R	*R*-square	Adjusted *R*-square	Std. error of the estimate	*R*-square change	Change statistics			Sig. *F* change	Durbin-Watson
						F change	df1	df2		
1	.712[a]	.504	.441	.12769	.504	2.016	4	535	.000	–
2	.743[b]	.552	.473	.12798	.048	1.021	3	532	.049	2.632

Note: a – Predictors: (Constant*), LogYearsonJSE, LogEmployees, Debtratio, Leverage*; b – Predictors: (Constant), *LogYearsonJSE, LogEmployees, Debtratio, Leverage, LogEnvironTra, LogEnviroAud, LogEnergyEffe*.

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Table 4. Coefficients of a dependent variable: Water consumption

Model	Unstandardized Coefficients		Std. Coefficients	*T*	Sig.	Collinearity statistics	
	B	Std.Error	Beta			Tolerance	VIF
(Constant)	.783	.211	–	.201	.001	–	–
LogENVIRONTRAIN	.521	.212	.456	.812	.042	.755	1.325
LogENERGYEFF	.423	.571	.331	.462	.067	.781	1.281
LogENVIRONAUD	.681	.771	.401	.441	.047	.602	1.661
LogYearsonJSE	–.301	.481	–.612	–.331	.672	.699	1.431
LogEmployees	–.071	.223	.812	.114	.004	.751	1.331
Debtratio	.110	.634	–.452	.771	.443	.549	1.821
Leverage	.411	.514	–.712	–.119	.003	.596	1.679

Equally, two control variables (*LogEmployees*, p = .004; *Leverage*, p = .003) display a significant relationship with water consumption. This suggests that a reduced number of employees increases fresh water consumption. Also, an increase in using debt leads to an upsurge in water consumption. This can be ascribed to the assumption that companies with high leverage are more monitored by the shareholders.

3.3. Carbon emission (*H3*)

Table 5 indicates the R-square = .991, adjusted R-square = .978, F (4, 535) = 277.12, p < .001. Conversely, EMAP did not significantly forecast carbon dioxide after curbing the control variables' influences, R-square change = .002, F (3, 532) = .871, p = .061. Furthermore, Table 5 shows the R-square of .984, specifying that EMAP account for a 98.4% contribution to carbon emissions in cement and mining companies in South Africa. This indicates a strong association between carbon emissions (scope 1 and 2) and EMAP. The adjusted R-square shows that the model produced a 97.6% predictability. This means that a unit change in carbon emissions is explained up to 0.976 by a change in EMAP (*LogEnvironTra, LogEnviroAud*, and *LogEnergyEffe*).

Each variable was assessed to determine its strengths in the regression model, as shown in Table 6.

From Table 6, *LogENVIRONTRAIN* (p = .765), *LogENERGYEFF* (p = .342), and *LogENVIRONAUD* (p = .652) show no significant capacity to predict environmental sustainability performance proxied by carbon emissions. Similarly, Table 6 shows

Table 5. Carbon emissions: Model summary

Model	R	*R*-square	Adjusted *R*-square	Std. Error of the Estimate	*R*-square Change	Change statistics			Sig. *F* Change	Durbin-Watson
						F change	df1	df2		
1	.991[a]	.982	.978	.42128	.978	277.12	4	535	.000	–
2	.992 [b]	.984	.976	.42178	.002	.871	3	532	.061	2.516

Note: a – Predictors: (Constant), *LogYearsonJSE, LogEmployees, Debtratio, Leverage*; b – Predictors: (Constant), *LogYearsonJSE, LogEmployees, Debtratio, Leverage, LogEnvironTra, LogEnviroAud, LogEnergyEffe*.

Table 6. Coefficients of a dependent variable: Carbon emissions

Model	Unstandardized coefficients		Std. Coefficients	*T*	Sig.	Collinearity statistics	
	B	Std. error	Beta			Tolerance	VIF
(Constant)	–.543	.111	–	–.54	.048	–	–
LogENVIRONTRAIN	–.329	.712	.211	–.014	.765	.824	1.213
LogENERGYEFF	–.112	.014	–.54	–.66	.342	.753	1.328
LogENVIRONAUD	.412	.662	.213	.571	.652	.818	1.223
LogYearsonJSE	–.223	.230	–.612	–.331	.004	.699	1.431
LogEmployees	–.064	.287	–.71	–.10	.603	.584	1.712
Debtratio	.523	.224	–.332	.615	.768	.648	1.551
Leverage	.321	.237	–.224	–.102	.634	.606	1.651

that EMAP are insignificant in predicting carbon emissions, F (7, 532) and p = .061 (insignificant). Therefore, the null hypothesis (*H3*) is rejected and not supported.

However, as shown in Table 6, EMAP such as *LogENVIRONTRAIN* (B = –.329) and *LogENERGYEFF* (B = –.112) show an insignificant negative relationship with carbon emissions, meaning that a decrease in any of the two insignificantly increases carbon emissions. In addition, the beta coefficient for the number of permanent employees (*LogEmployees*) and the number of years listed on the JSE (*LogYearsonJSE*) negatively predicts carbon dioxide emissions. Put differently, companies are more significantly interested in reducing carbon dioxide emissions in their early years of their listing on the JSE and also in their early periods when they have a few permanent employees. Finally, positive but insignificant leverage (p = .634) and debt ratio imply that high debts cannot predict carbon dioxide emissions significantly.

4. DISCUSSION

The first hypothesis (*H1*) predicts a significant relationship between EMAP and environmental sustainability proxied by recycled water. The results show a significant relationship; therefore, *H1* is supported. This suggests that recycled water is improving the environmental sustainability performance of the cement and mining companies in South Africa. Similar findings were observed in studies by Agyemang et al. (2021) and Neeveditah et al. (2017).

Based on Kumar and Dua's (2022) view on the need to rationally interpret the regression model results in studies encompassing EMA and financial performance, the study interpreted the outcome of this hypothesis (*H1*) in two ways. Firstly, the significant relationship between recycled water and EMAP within the sampled companies means that companies enjoy financial benefits from water recycling. Dzomonda and Fatoki (2021) and Simionescu et al. (2020) argue that efficient water recycling reduces fresh water usage and waste treatment costs as less fresh water is used. Secondly, the water recycling efficiency helps to reduce water consumption scrutiny with stakeholders as low levels of fresh water consumption are used. So far, the results show that this is a major area that the sampled companies can use to reduce climate change. However, the sampled companies must maintain a good check on recycled water levels because, currently, the companies are using excessive levels of fresh water consumption. This is important because Filho et al. (2018) and Silva da Rosa et al. (2020) postulate that increased water consumption directly contributes to climate change.

The second hypothesis (*H2*) predicts a significant relationship between EMAP and environmental sustainability proxied by water consumption. The results show a significant positive relationship between EMAP and water consumption; therefore, *H2* is accepted. Furthermore, the results infer that EMAP, through their expenditure values, possess a positive and significant association with water consumption across 45 South African cement and mining companies. Thus, an increase in expenditure on EMAP is expected to accelerate these companies in South Africa to attain higher water consumption efficiency. This is in line with previous literature that identified that water consumption has a positive relationship with EMAP (Maama et al., 2020; Nisar et al., 2021). In contrast, the findings do not support the findings by Xu et al. (2022) on the relationship between EMAP and the water efficiency of the China National Environmental Monitoring Centre. Furthermore, using Iraqi companies, Hamdan (2018) also observed that audits were of no effect in attaining sustainability development.

The significant result of the relationship between water consumption and EMAP is essential because South Africa is on the edge of a sustainability threat if environmental sustainability constructs such as water consumption are not adequately managed (Dzomonda & Fatoki, 2021). Given this situation, the study argues that companies such as the cement and mining companies in South Africa, which developed proactive strategies for reducing the water crisis, are expected to improve their image and increase legitimacy in the perception of stakeholders, specifically the community and government.

Reviewing the impact of control variables on water consumption indicates that not every hypothesized control variable significantly influenced water consumption. For example, *logEmployees*

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(p = .004) and *Leverage* (p = .003) had a significant impact on water consumption. The number of years listed on the JSE and debt ratio did not reflect any significant impact on water consumption.

The third hypothesis (*H3*) predicts a significant relationship between EMAP and environmental sustainability proxied by carbon emissions. The results indicate that *H3* is rejected. This means that EMAP were not significant in predicting carbon emissions in the cement and mining companies in South Africa but only after restricting the impact of the control variables. It reflects that control variables were more effective in predicting the dependent variable (carbon emissions). Similarly, Doda et al. (2016) found a neutral link between carbon emissions and EMAP. However, this contradicts Pratiwi et al.'s (2020) and Aslam et al.'s (2021) findings of a positive relationship. These results suggest that the three EMAP of the sampled companies do not affect carbon emissions and correct the behavior of these companies in excess carbon emissions. This suggests that even though EMAP are drivers of environmental performance, their influence is lesser if they are voluntarily implemented.

Furthermore, an alternative explanation is that the EMAP adopted by a large percentage of cement and mining companies is not adequately impact-orientated. As a result, the sampled companies may be anticipating that the existence of various EMAP is decreasing their GHG emissions without evaluating the level to which EMAP are actually doing so. Therefore, more attention should be paid not to the existence but to the effect of EMAP on the carbon emissions that they are implemented to be lessening.

Another possible explanation for this negative relationship could be that audit reports' recommendations on carbon emissions may not be adequately implemented. However, overcoming the insignificant relationship between carbon emissions and EMAP could bring the responsible departments and staff to embrace adopting a carbon emission plan into the performance assessment of employees. This suggests that the audit findings have to be better applied as a fundamental benchmark for employee appraisal, remuneration, and punishment. Additionally, cement and mining companies in South Africa should ensure that there is an appropriate system to warrant the effective putting of audit recommendations into practice. This is important because increases in carbon emissions push cost rises through carbon tax for business and public analysis of industrial carbon emissions (Busch et al., 2022).

A lack of relationship between EMAP and carbon emissions indicates that the sampled companies may not enjoy financial benefits from reduced carbon emissions, such as emissions rebates. This indicates that the cement and mining companies' adoption of EMAP may not be motivated by possible financial benefits to the company or shareholders' return on equity. Information acquired from the annual integrated reports, sustainability reports, and environmental reports of cement and mining companies in South Africa does not depict financial drive as a motivation for the sampled companies' EMAP adoption. Instead, it displays that cement and mining companies in South Africa are entrenched in their concern to yield lessening environmental impacts and complying with the legislation. In addition, there is a critical need to implement a proactive stance in conserving the environment in the sampled companies.

Therefore, based on the carbon emissions metric, it is confirmed that cement and mining companies are not fully committed to sustainable development goals in South Africa and internationally. Therefore, Mbedzi et al. (2020, p. 13) argue that South African companies in the mining sector need to reconsider their environmental sustainability assurance urgently. This also supports the results that cement and mining companies in South Africa need to reconsider their EMAP in order to reduce carbon emissions. Busch et al. (2022) agree and allude that work by a company to reduce its carbon emissions enhances its sustainability.

Lastly, the insignificant relationship between carbon emissions and EMAP implies that formal EMA training by the government can improve the absence of a relationship between EMA and carbon emissions. According to Kumar and Dua (2022), a lack of proper training on environmental management issues could likely lead to impediments in understanding the importance of environmentally related data. This may show that cement and mining companies in South Africa are still precisely managing the environment traditionally. Furthermore, it can mean that the inclusiveness of EMA is still absent in South Africa.

CONCLUSION

This study is essential as corporate managers require modern evidence concerning this association between EMAP and environmental sustainability. The findings of this study present a unique benefit for corporate decision-makers, particularly those in the cement and mining sectors in South Africa of the EMAP that effectively improve environmental sustainability. This helps to increase the understanding of the corporate managers concerning their business activities' environmental sustainability.

EMAP role in increasing environmental sustainability within the cement and mining in South Africa has been established. This study has been influential in establishing the relationship between EMAP and environmental sustainability within 45 JSE-listed cement and mining companies. EMAP were measured by environmental auditing, environmental training, and energy efficiency. Environmental sustainability was proxied by carbon emissions, water consumption, and recycled water. The results indicate that two environmental sustainability measures, namely, recycled water and fresh water consumption, have a significant and positive relationship with EMAP.

Conversely, one environmental sustainability proxy (carbon emissions) did not show a significant relationship with EMAP. Therefore, it can be concluded that EMAP adopted by the sampled companies can partially improve upswing environmental sustainability. These companies must expand their selection of EMAP currently adopted to ensure that other environmental sustainability measures, such as carbon emissions, are extensively reduced.

The study has, in various ways, contributed to extant literature; the study used data from the cement and mining companies in South Africa to understand how their selected EMAP are enhancing environmental sustainability, which up to now has not been undertaken in environmental literature. Additionally, this study provides further empirical evidence that certain EMAP cannot improve environmental sustainability. However, this has to be taken with caution as it is only based on data from JSE-listed cement companies in South Africa; therefore, any variance in the context under analysis might change the findings.

The consequence of this study rests on the cement and mining companies in South Africa, being among the major contributors to adverse environmental impacts, to lessen environmental impacts by adopting other EMAP that can increase environmental sustainability, especially carbon emissions, because they are directly linked to climate change, which is an utmost threat to humanity. Further studies can be conducted to evaluate the effect of slack resources, such as financial resources, on adopting EMAP. Furthermore, future studies can use qualitative research methods to overcome the challenges of the quantitative method.

AUTHOR CONTRIBUTIONS

Conceptualization: Thomas Nyahuna.
Data curation: Thomas Nyahuna.
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Investigation: Thomas Nyahuna.
Methodology: Thomas Nyahuna.
Project administration: Matthys Swanepoel.
Supervision: Matthys Swanepoel.
Validation: Thomas Nyahuna.
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Writing – review & editing: Matthys Swanepoel.

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