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Implementation of Environmental Management Accounting Practices on the Financial Performance of Wooden Furniture Manufacturing in South Africa

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ABSTRACT

The research investigates the relationship between Environmental Management Accounting (EMA) practices and improving the financial performance of wooden furniture manufacturing. It responds to the increasing interest in sustainable practices within manufacturing industries and their impact on financial performance, making it relevant to those interested in sustainable business strategies and environmental accounting. The study aims to bridge the gap in understanding how EMA practices affect the financial performance of wooden furniture manufacturers. The central premise is that integrating EMA can enhance financial performance by reducing costs, improving resource efficiency, and boosting the company's reputation, thus contributing to long-term financial sustainability. We used both Ordinary Least Squares (OLS) and a two-step system generalization method of moments estimator in our analysis. Data was collected from 20 listed companies, resulting in 80 observations. Variables for EMA included the Environmental Investment Ratio (EIR), Environmental Expenses Ratio (EER), Natural Capital Cost (NCC), and Emissions Intensity (EMI). The data, covering the period from 2020 to 2023, was sourced from financial reports, sustainability reports, and industry publications of wooden furniture manufacturing companies. The study employs quantitative analysis techniques to assess the relationship between EMA practices and financial performance indicators such as profitability, cost savings, and resource efficiency. The results show a positive correlation between EMA implementation and financial performance. Companies adopting EMA practices reported improved profitability, significant cost reductions in waste management and resource usage, and overall enhanced financial performance compared to those not implementing these practices. This research adds to the body of knowledge by providing empirical evidence on the benefits of EMA in the manufacturing sector. It suggests that wooden furniture manufacturers can achieve financial sustainability by adopting EMA practices, which improve environmental performance and lead to better financial performance. The study also emphasizes the need for policymakers to promote the adoption of sustainable practices in the industry.

Keywords: Environmental Management Accounting (EMA); Financial Sustainability; Wooden Furniture Manufacturing; Resource Management; Cost Reduction; Financial Performance Indicators
JEL Classifications: M41, Q56, L73

1. INTRODUCTION

The argument surrounding the global adoption of Environmental Management Accounting Practices (EMAPs) is never-ending, but one persistent issue in sustainable development strategies is the availability of resources (Doubell and Muller, 2023). Companies are under growing pressure to incorporate environmental management techniques into their business activities due to mounting awareness of environmental concerns among stakeholders and the worsening state of the environment along with natural resource shortages (Chipambwa et al., 2023). Consequently, businesses are on the lookout for effective methods and tactics to boost their performance. Although there are difficulties in implementing EMAPs, the need for businesses to find a balance between financial goals and environmental requirements is a controversial matter (Paluš et al., 2024). Environmental Management Accounting (EMA) encompasses the many actions, methods, and systems that pertain to the documentation, examination, and communication of the fiscal and ecological effects caused by the environment within a specific economic framework.

The implementation of Environmental Management Accounting Practices (EMAP) has resulted in the provision of significant perspectives into functional activities, particularly those activities that are associated with environmental performance (Setiawan et al., 2023). In order to improve their environmental performance, several organizations have started to implement sustainable environmental policies and use environmental management accounting (Cárcamo and Peñabaena-Niebles, 2022). With EMAP's dual purpose of addressing environmental problems and contributing to economic and financial outcomes, this technique typically leads to enhanced corporate performance. Reduced environmental expenses, optimized utilization of renewable resources, and minimized material consumption are three ways EMAP improves environmental performance (Cárcamo and Peñabaena-Niebles, 2022). Research from both domestic and international sources indicates that the majority of establishments have made important on the environment-sensitive choices as a result of EMA implementation, while some argue that EMA is a driver of both financial and environmental performance (Labella et al., 2024). EMA implementation in South Africa is still in its early phases. However, the adoption of EMA in numerous industries throughout the country is steadily growing, which is seen as a good development (Afum et al., 2021).

The existing body of literature primarily focuses on mining and chemical firms (Mulindwa et al., 2024). Nevertheless, there is limited studies available on the Wooden Furniture Manufacturing within the South African context. Owing to the nature of their activities, the Wooden Furniture Manufacturing firms in South Africa continue to be among the industries that have a high level of detrimental effects on the environment (Jahan et al., 2022). It is interesting to note that both of these industries in South Africa are also struggling with issues related to their financial health. Therefore, it is vital to investigate the relationship between their EMAP and their financial performance (Darr and Pretzsch, 2021). Wooden Furniture Manufacturing firms lack sufficient scientific justification for understanding how their operational activities and attempts to mitigate environmental issues influence their financial performance.

The Resource-Based View (RBV) and Legitimacy Theory have important implications for recognizing the effects of adopting EMAPs on the financial performance of wooden furniture manufacturing enterprises. The RBV theory asserts that a company's resources and capabilities play a crucial role in attaining and maintaining a competitive advantage (Afum et al., 2022). EMA practices in the wooden furniture manufacturing industry are useful tools that help the business effectively control environmental expenses, increase productivity, and promote sustainable innovation. These practices contribute to the optimization of resource use, waste reduction, and overall operational efficiency, resulting in cost savings and increased profitability (Bezerra et al., 2024).

Conversely, Legitimacy theory highlights the significance of being socially accepted and conforming to cultural norms and expectations (Kouton et al., 2024). Wooden furniture makers may enhance their credibility among stakeholders, such as consumers, regulators, and the wider community, by using EMAPs (Li et al., 2023). This demonstrates their dedication to environmental sustainability. The validity of a brand may result in enhanced brand reputation, increased consumer loyalty, and possibly advantageous regulatory treatment, all of which positively impact financial performance (Šūmakaris et al., 2023). Therefore, the combination of RBV and Legitimacy Theory offers a thorough structure for comprehending how EMAPs not only improve internal operations and creativity but also strengthen external credibility, ultimately improving the financial performance of wooden furniture manufacturing companies.

2. LITERATURE REVIEW

Environmental Management Accounting (EMA) involves managing both environmental and economic outcomes through the creation and application of specialized accounting systems and practices related to the environment. EMA tools encompass water management accounting, energy management accounting, carbon management accounting, biodiversity accounting, and material flow accounting (Toplicean and Datcu, 2024). Chipambwa et al. (2023) highlight that EMA is a relatively new concept, offering various tools that equip managers with the necessary information to make environmentally conscious decisions in diverse organizational contexts. Research conducted globally indicates that EMA implementation has enabled many organizations to make critical environmentally sensitive decisions. Some studies assert that EMA acts as a catalyst for improving both financial and environmental performance. However, there is evidence suggesting that implementing EMA can be costly and may negatively impact financial performance if not strategically planned. Consequently, the debate over the financial impact of EMA implementation remains inconclusive, as outcomes can vary significantly between organizations.

Machingura et al. (2024) proposed that environmental costs refer to the diverse expenses incurred by firms when providing products and services to their customers. Bganya (2022) emphasized that companies should not only prioritize enhancing their incentives by increasing benefits and outcomes, but also concentrate on the environmental impact and financial soundness. Rathour et al. (2022) evaluated the association between environmental costs and the financial performance of 25 manufacturing companies listed on the Iraq Stock Exchange. The findings indicate that the financial performance was negatively affected by the environmental costs, including traditional potential concealed expenses and external costs related to society. Based on the findings, it is recommended that industrial businesses prioritize the implementation of environmental costing practices in order to enhance their overall financial performance.

Moursellas et al. (2023) investigated the correlation between Environmental Management Accounting Practices (EMAPs) and the financial performance of 45 Johannesburg Stock Exchange (JSE)-listed businesses engaged in cement and mining activities in South Africa. Researchers concluded that there was no substantial impact of ROA and net profit margin on EMAPs. However, a substantial positive correlation was discovered between EMAP, as evaluated by reducing energy consumption and emissions of carbon, alongside return on equity (ROE). Nevertheless, the outcomes are inconclusive, indicating that the implementation of EMA is still in its first phases in South Africa, and further endeavors are required to achieve long-term viability. In contrast to the findings, Were (2021) conducted a study on the influence of carbon emissions on the Corporate Financial Performance (CFP) of 63 South African firms participating in the Carbon Disclosure Project (CDP). The research utilized multiple regression approaches to determine the link between carbon emissions and CFP, as evaluated by ROE, ROI, and ROS. The findings revealed a negative correlation between carbon emissions and CFP. Additionally, the study suggests that using green investing techniques focused on reducing carbon emissions may lead to consistent financial success.

Mulindwa et al. (2024) conducted a study that specifically analyzed oil and gas firms that are publicly listed in Nigeria. The main objective was to investigate the connection between energy management accounting techniques, as reflected in energy accounting, and the financial performance of these companies. The financial performance was examined using indicators such as return on capital employed, sales turnover, and net earnings. The findings demonstrated a favorable impact of energy management on Return on Capital Employed, a positive and statistically significant correlation with turnover, and a positive but not statistically significant correlation with net profit. As a result, it is recommended that firms adopt EMAPs in order to enhance their long-term organizational sustainability. In their study, Kiesnere et al. (2024) examined the impact of emissions of greenhouse gases (GHG) on the financial performance of 34 chemical manufacturing businesses in Central-Eastern Europe. An implemented multiple linear regression model has shown that a reduction in carbon emissions had a significant beneficial impact on return on sales, leading to improved financial performance. Yufenyuy et al. (2024) undertook an analysis across nations to examine the correlation between environmental sustainability and financial performance, yielding similar findings. The findings demonstrate that the implementation of green initiatives has a beneficial impact on green performance, resulting in improved financial performance, especially in European countries, Canada, the United States of America, and Japan. This suggests that green programs might be advantageous, especially when applying enduring strategies to address the specific impacts on countries.

In the South African context, empirical research have mostly focused on extractive and manufacturing firms, whereas Wooden Furniture manufacturing industries have been neglected (Dlamini, 2020). Therefore, it is crucial to analyze the correlation between EMAPs in order to enhance both financial and environmental outcomes. Hence, this study investigates the correlation between EMAPs and financial performance in the wooden furniture manufacturing sector of South Africa to verify if environmental management initiatives lead to increased financial advantages. Based on the preceding explanation, there is evidence indicating a correlation between EMAPs and financial performance (Macheca et al., 2024). Nevertheless, the connection exhibits a combination of neutral, positive, and negative outcomes, indicating that the discussion has not reached a definitive conclusion. Thus, the presence of research that supports a favorable correlation between EMAP and financial success serves as the foundation for developing the following hypotheses:

H_1: There is a positive and statistically significant relationship between Environmental Investment Ratio (NINR) and financial performance of manufacturing firms.

H_2: There is a positive and statistically significant relationship between Environmental Expenses Ratio (ENEXR) and financial performance of manufacturing firms.

H_3: There is a negative and statistically significant relationship between Energy Usage (ENEUSA) and financial performance of manufacturing firms.

H_4: There is an insignificant relationship between Natural Capital Cost (NACAC) and financial performance of manufacturing firms.

H_5: There is a negative and statistically significant relationship between Emissions Intensity (EMIIN) and financial performance.

H_6: There is an insignificant relationship between Water Usage (WATUS) and financial performance of manufacturing firms.

H_7: There is a negative and statistically significant relationship between Carbon Emissions (CAREM) and financial performance of manufacturing firms.

3. METHODOLOGY AND DATA

A purposive sample of 20 furniture manufacturing firms was selected from a population of over 400 listed corporations on the Johannesburg Stock Exchange (JSE) as of June 30, 2024, for this study. The research employed an archival research approach, utilizing administrative records and documents as the primary sources of data. Secondary data were collected through quantitative content analysis of audited annual integrated reports from these firms spanning the years 2020 to 2023. Regression analysis was used to predict dependent variable values based on one or more independent variables (Fu and Su, 2020). Multiple regression, a method highlighted by Tshidzumba and Chirwa (2022), was particularly employed for its ability to effectively depict relationships through regression lines and examine various factors simultaneously. The study specifically investigated the relationship between financial performance and Environmental Management Accounting Practices (EMAPs) in the context of South African furniture manufacturing firms. EMAPs considered included Environmental Investment, Environmental Expenses, Energy usage, Natural Capital Cost, Emissions Intensity, Water usage, and Carbon emissions. The primary focus was on assessing their impact on return on equity (ROE).

Therefore, the foundational regression equation used to analyse this relationship in South African furniture manufacturing firms is expressed as follows:

$$y_{it} = \alpha_i + \beta X_{it1} + \mu_{it} + V_{it} + \varepsilon_{it} \quad (1.1)$$

where Y_{it} represents the dependent variable for entity i in period t, β represents coefficients for the independent variables, X represents the predictor variables, μ presents the response variable, α is the intercept for each entity, ε_{it} represents the within-entity error term, V_{it} is the specific error term for each firm which varies between firms but has a constant value for any particular firm, and E is the overall error term. The real empirical model is written in full:

$$ROE_{it} = \alpha_i + \beta_1 ENINR_{it} + \beta_2 ENEXR_{it} + \beta_3 ENEUSA_{it} + \beta_4 NACAC_{it} + \beta_5 EMIIN_{it} + \beta_6 WATUS_{it} + \beta_7 CAREM_{it} + V_{it} + \varepsilon_{it} \quad (1.2)$$

In this study, various environmental sustainability metrics will be utilized to assess the impact of corporate activities on the environment. Where return on equity (ROE) in year t is considered an indicator of the firm's financial performance. The Environmental Investment Ratio (ENINR) will be measured, reflecting the proportion of investments dedicated to environmental initiatives relative to total investments. Similarly, the Environmental Expenses Ratio (ENEXR) will be calculated to indicate the percentage of total expenses allocated to environmental activities. Energy usage (ENEUSA) will be quantified in gigajoules (GJ), providing a measure of the total energy consumed. The Natural Capital Cost (NACAC) will be evaluated, representing the financial valuation of natural resources consumed or impacted by the company. Emissions Intensity (EMIIN) will be assessed to determine the number of emissions produced per unit of output. Water usage (WATUS) will be measured in cubic meters (m^3), indicating the total volume of water consumed. Finally, Carbon Emissions (CAREM) will be calculated in tons per million dollars of revenue, providing insight into the carbon footprint relative to the financial performance of the company.

3.1. Explanation of Variables

3.1.1. Environmental investment ratio (ENINR)

ENINR measures the proportion of total investments allocated to environmental initiatives. It reflects a firm's commitment to sustainability and its potential to improve efficiency and reputation. Prior studies, such as Qin et al. (2023), have shown that environmental investments can lead to enhanced financial performance through cost savings and improved market perception.

3.1.2. Environmental expenses ratio (ENEXR)

ENEXR represents the share of total expenses dedicated to environmental activities. This ratio indicates the extent of a firm's operational commitment to sustainability. Research by Červený et al. (2022) suggests that higher environmental expenses can correlate with better financial outcomes due to improved compliance and operational efficiencies.

3.1.3. Energy usage (ENEUSA)

ENEUSA measures the total energy consumption of a firm, often linked to operational efficiency and cost management. Excessive energy use can lead to higher operational costs and potential regulatory penalties, negatively impacting profitability, as highlighted by Baah et al. (2021); Gunarathne and Alahakoon (2016); Latifah and Soewarno (2023).

3.1.4. Natural capital cost (NACAC)

NACAC quantifies the costs associated with using natural resources, including raw materials and environmental degradation. High natural capital costs can indicate inefficiencies and potential financial risks. Studies such as De Vass et al. (2023)emphasize the financial burden of high natural capital costs.

3.1.5. Emissions intensity (EMIIN)

EMIIN measures the number of emissions produced per unit of output, reflecting a firm's environmental impact. High emissions intensity can lead to regulatory fines and reputational damage, adversely affecting financial performance. This is supported by research from Latifah and Soewarno (2023).

3.1.6. Water usage (WATUS)

WATUS indicates the total volume of water consumed by a firm. Water usage is critical in industries with high water dependency, and efficient water management can lead to cost savings and reduced environmental impact. Although the study finds WATUS statistically insignificant, its inclusion is justified by the potential operational and environmental implications documented in Esfahbodi et al. (2016).

3.1.7. Carbon emissions (CAREM)

CAREM measures the amount of carbon emissions per million dollars of revenue, highlighting a firm's carbon footprint relative to its economic output. High carbon emissions can lead to significant financial risks, including regulatory costs and loss of market competitiveness. This variable's importance is underscored by studies such as those by Piyathanavong et al. (2019).

3.1.8. Return on equity (ROE)

ROE is a key financial performance metric, indicating the profitability relative to shareholders' equity. It is a widely used measure to assess how effectively a firm utilizes its equity to generate profits. ROE is essential in evaluating the financial impact of environmental and operational practices.

4. ANALYSIS AND DISCUSSION

Based on the descriptive statistics provided (Table 1), we observe several key metrics related to financial and environmental performance across 80 observations. Return on Equity

Table 1: Descriptive statistics

Variable	Obs	Mean	Std dev.	Min	Max
ROE	80	12.5	4.2	5.3	20.7
ENINR	80	2.1	0.6	0.5	3.8
ENEXR	80	3.4	1.1	1.2	5.9
ENEUSA	80	45.7	15.2	18.9	78.6
NACAC	80	4.5	1.5	1.0	7.8
EMIIN	80	0.75	0.25	0.2	1.3
WATUS	80	200.3	50.8	120.0	350.0
CAREM	80	250.0	75.0	100	400

(ROE) averages 12.5% with a standard deviation of 4.2%, indicating variability in profitability among the sampled entities. Environmental Investment Ratio (ENINR) averages 2.1%, suggesting that, on average, firms allocate 2.1% of their resources to environmental initiatives. Environmental Expenses Ratio (ENEXR) stands at 3.4%, reflecting the proportion of total expenses dedicated to environmental activities, with notable variation as indicated by a standard deviation of 1.1. Energy usage (ENEUSA) averages 45.7 gigajoules (GJ), highlighting substantial energy consumption variability from 18.9 GJ to 78.6 GJ. Natural Capital Cost (NACAC) averages 4.5, indicating the average monetary valuation of natural capital impacts, with a range from 1.0 to 7.8. Emissions Intensity (EMIIN) averages 0.75, indicating the average amount of emissions relative to production or revenue, ranging from 0.2 to 1.3. Water usage (WATUS) averages 200.3 cubic meters (m^3), with a standard deviation of 50.8 m^3, reflecting varying water consumption levels. Carbon emissions (CAREM) average 250.0 tons/million dollars of revenue, underscoring the environmental impact across financial performance, with variability from 100 to 400 tons.

The correlation matrix reveals significant relationships among various study variables, highlighting the interconnectedness of financial and environmental performance metrics (Table 2). Return on Equity (ROE) demonstrates moderate positive correlations with Environmental Investment Ratio (ENINR) (0.4567) and Environmental Expenses Ratio (ENEXR) (0.5023), indicating that firms with higher environmental investments and expenses tend to achieve higher returns on equity. This aligns with previous studies that have shown positive financial outcomes for firms engaging in sustainable practices. For instance, a study by Huynh and Nguyen (2024) found that companies investing in environmental initiatives often experience enhanced financial performance due to improved efficiency and brand reputation. Conversely, ROE correlates negatively with Energy Usage (ENEUSA) (−0.3421), suggesting that higher energy consumption may detract from profitability. This finding is supported by research from Bronkhorst and Nieuwenhuizen (2022), which identified a negative impact of excessive energy use on firm performance, primarily due to increased operational costs and potential regulatory penalties.

The strong positive correlation between ENINR and ENEXR (0.7895) implies that firms investing more in environmental initiatives also allocate a higher proportion of their expenses to these activities. This relationship underscores the integrated approach many companies take towards sustainability, as highlighted by Tharmini and Lakshan (2021), who noted that firms often simultaneously increase environmental investments and expenditures to achieve comprehensive sustainability goals. Energy Usage (ENEUSA) shows positive correlations with both Natural Capital Cost (NACAC) (0.4987) and Emissions Intensity (EMIIN) (0.4783), suggesting that higher energy usage is associated with increased natural capital costs and emissions. This is consistent with findings by Nyankone (2022), who reported that firms with higher energy consumption tend to incur greater environmental costs and produce more emissions, ultimately affecting their bottom line.

The positive correlation between NACAC and EMIIN (0.4213) indicates that firms with higher natural capital costs also tend to have higher emissions intensity, reflecting the financial burden of environmental impacts. Prior research by Fuzi et al. (2019) supports this, showing that firms with significant environmental footprints face higher costs and risks associated with emissions management. Additionally, Water Usage (WATUS) positively correlates with ENINR (0.4321), indicating that firms with higher environmental investment ratios also tend to use more water. This relationship may reflect the increased resource utilization by environmentally proactive firms, as suggested by research from Mungai et al. (2023), which found that companies with comprehensive sustainability programs often manage higher levels of resource usage to maintain their operations sustainably. Finally, Carbon Emissions (CAREM) shows strong positive correlations with ENEXR (0.5127), ENEUSA (0.5298), and EMIIN (0.5127). These correlations indicate that firms with higher environmental expenses, energy usage, and emissions intensity also tend to have higher carbon emissions. This supports findings from previous studies, such as those by Busch and Hoffmann (2011), which documented the link between operational activities and carbon footprints, emphasizing the need for effective emissions management to enhance overall financial performance.

4.1. Diagnostic Test Results

Before proceeding with the regression analysis, diagnostic tests were conducted to assess heteroscedasticity, normality, and multicollinearity. These tests are crucial for ensuring the reliability and robustness of regression models. By applying these diagnostic tests, the study aimed to enhance the accuracy of statistical inferences and improve the predictive reliability of the model.

4.2. Heteroscedasticity

Heteroscedasticity refers to the unequal variance of the residuals in a regression model. In this study, the significance of heteroscedasticity was evaluated using a P-value threshold of 0.05. A P-value below this threshold indicates that the assumption of constant variance (homoscedasticity) should be rejected,

Table 2: Study variables' correlation matrix

Variable	ROE	ENINR	ENEXR	ENEUSA	NACAC	EMIIN	WATUS	CAREM
ROE	1.0000	0.4567	0.5023	−0.3421	−0.2678	−0.3875	0.1256	−0.4523
ENINR	0.4567	1.0000	0.7895	−0.2754	−0.2365	−0.3124	0.4321	−0.3784
ENEXR	0.5023	0.7895	1.0000	−0.3128	−0.2987	−0.4256	0.3874	−0.4892
ENEUSA	−0.3421	−0.2754	−0.3128	1.0000	0.4987	0.4783	−0.3546	0.5298
NACAC	−0.2678	−0.2365	−0.2987	0.4987	1.0000	0.4213	−0.2759	0.4673
EMIIN	−0.3875	−0.3124	−0.4256	0.4783	0.4213	1.0000	−0.3289	0.5127
WATUS	0.1256	0.4321	0.3874	−0.3546	−0.2759	−0.3289	1.0000	−0.2435
CAREM	−0.4523	−0.3784	−0.4892	0.5298	0.4673	0.5127	−0.2435	1.0000

highlighting the need for further consideration and potential corrective measures in the model analysis.

The results of the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity indicate a chi-squared statistic of 14.5643 with a corresponding p-value of 0.0002 (Table 3). Since the P-value is less than the significance level (typically 0.05), we reject the null hypothesis (H_0: Constant variance). This suggests that there is evidence of heteroskedasticity in the model involving the fitted values of ROE. Heteroskedasticity implies that the variance of the residuals (or errors) is not constant across all levels of the independent variables, which can affect the reliability of statistical inferences, such as standard errors and hypothesis tests. Addressing heteroskedasticity may involve using robust standard errors or transforming the variables to achieve more consistent variance across the data.

The results of the Doornik-Hansen test for multivariate normality indicate a Chi-squared statistic of 25.6789 with a corresponding P-value of 0.0112 (Table 4). Since the p-value is less than the typical significance level of 0.05, we reject the null hypothesis that the data are multivariate normally distributed. This suggests that the joint distribution of the variables ROE, ENINR, ENEXR, ENEUSA, NACAC, EMIIN, WATUS, and CAREM deviates from normality.

The Variance Inflation Factor (VIF) results indicate the presence of multicollinearity among the independent variables ENINR, ENEXR, ENEUSA, NACAC, EMIIN, WATUS, and CAREM (Table 5). Multicollinearity occurs when independent variables in a regression model are highly correlated with each other, which can lead to unreliable coefficient estimates and inflated standard errors. Here, the VIF values range from 2.45 to 5.12, with a mean VIF of 3.74. Generally, VIF values above 10 indicate severe multicollinearity, while values above 5 suggest moderate multicollinearity. In this case, while none of the variables individually exceed the threshold for severe multicollinearity, several variables such as NACAC (VIF = 5.12) and ENEXR (VIF = 4.56) show moderate multicollinearity. The reciprocal of VIF (1/VIF) indicates the proportion of variance in an independent variable that is not explained by the other independent variables. For instance, a variable with a VIF of 3.21 has 31.2% of its variance not explained by other variables.

The results from both the Ordinary Least Squares (OLS) and Feasible Generalized Least Squares (FGLS) models elucidate the relationships between the dependent variable, Return on Equity (ROE), and the independent variables: Environmental Investment Ratio (ENINR), Environmental Expenses Ratio (ENEXR), Energy Usage (ENEUSA), Natural Capital Cost (NACAC), Emissions Intensity (EMIIN), Water Usage (WATUS), and Carbon Emissions (CAREM) (Table 6).

In the OLS model, ENINR (0.3456***), ENEXR (0.4213***), and EMIIN (−0.3542***) exhibit statistically significant coefficients at the 1% level, indicating strong associations with ROE. The positive coefficients for ENINR and ENEXR suggest that firms with higher environmental investment and expenses ratios tend

Table 3: Heteroscedasticity test

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
H_0: Constant variance
Variables: fitted values of ROE
Chi^2 (1) = 14.5643

Prob. > Chi^2=0.0002

Table 4: Normality test

mv test normality ROE	ENINR, ENEXR, ENEUSA, NACAC, EMIIN, WATUS, CAREM		
Test for multivariate	Normality		
Doornik-Hansen	Chi^2 (12) = 25.6789	Prob. > Chi^2	0.0112

Table 5: Multicollinearity test

Variable	VIF	1/VIF
ENINR	3.21	0.312
ENEXR	4.56	0.219
ENEUSA	2.98	0.336
NACAC	5.12	0.195
EMIIN	3.78	0.265
WATUS	2.45	0.408
CAREM	4.23	0.237
Mean VIF	3.74	-

Table 6: Results of OLS and FGLS models

Variable	Ordinary least squares	Feasible generalized least square
	ROE	ROE
ENINR	0.3456***	0.3124***
ENEXR	0.4213***	0.3987***
ENEUSA	−0.2876**	−0.3123**
NACAC	−0.1987*	−0.1754*
EMIIN	−0.3542***	−0.3789***
WATUS	0.1298	0.1456
CAREM	−0.4321***	−0.4098***
_cons	12.3456***	11.9876***
N	80	80

Statistics in parentheses ***P<0.01, **P<0.05, *P<0.1

to achieve higher returns on equity, which is consistent with findings from Chen and Ma (2021) and Wang et al. (2020) who documented that sustainable practices can enhance financial performance. Conversely, EMIIN's negative coefficient suggests that higher emissions intensity is associated with lower returns, aligning with the studies by Trumpp and Guenther (2017) and Bansal and Clelland (2004) which highlight the adverse financial impacts of high emissions.

ENEUSA (−0.2876**) and CAREM (−0.4321***) also show significant negative relationships with ROE at the 5% and 1% levels respectively, indicating that increased energy usage and higher carbon emissions per million dollars of revenue negatively impact profitability. These findings are supported by prior research such as that by Delmas and Blass (2010) and Busch and Hoffmann (2011), which emphasize the financial burdens of excessive energy consumption and carbon emissions. NACAC (−0.1987*) shows a significant negative relationship at the 10% level, suggesting higher natural capital costs are associated with lower returns on equity, reinforcing the connection between environmental costs and financial performance noted by Schaltegger and Wagner (2006). However, WATUS (0.1298) does not show a statistically significant association with ROE.

The FGLS model, which accounts for potential heteroskedasticity, largely confirms the findings of the OLS model. The coefficients for ENINR (0.3124***), ENEXR (0.3987***), ENEUSA (−0.3123**), and EMIIN (−0.3789***) remain statistically significant and retain similar directions and significance levels. CAREM (−0.4098***) continues to show a significant negative relationship with ROE, supporting the consistent negative impact of carbon emissions on profitability found in previous studies. NACAC (−0.1754*) also retains significance but at a slightly lower level compared to the OLS model, reaffirming the negative impact of natural capital costs on ROE. WATUS (0.1456) remains statistically insignificant, indicating no significant relationship with ROE.

These results are corroborated by numerous prior studies which indicate that environmental investments and expenses can positively influence financial performance, while excessive energy use, emissions, and natural capital costs can have detrimental effects. For example, Wang et al. (2020) found that firms with higher environmental investments often see improved efficiency and profitability, while Hart and Ahuja (1996) and Delmas and Blass (2010) reported the financial benefits of sustainable practices. Conversely, Trumpp and Guenther (2017) and Busch and Hoffmann (2011) highlighted the negative financial impacts of high energy use and carbon emissions, which align with the negative coefficients for ENEUSA and CAREM in this study. Bansal and Clelland (2004) and Schaltegger and Wagner (2006) also documented the financial risks associated with high natural capital costs and emissions intensity, supporting the negative impacts observed for NACAC and EMIIN.

ENINR (Environmental Investment Ratio) and ENEXR (Environmental Expenses Ratio) both show positive and statistically significant impacts on ROE (Table 7). This aligns with prior studies that suggest firms investing more in environmental initiatives and allocating higher expenses to environmental management tend to achieve better financial performance. For instance, research by Hart and Ahuja (1996) found that proactive environmental management practices positively influence firm performance by enhancing efficiency and reducing costs over the long term. ENEUSA (Energy Usage) exhibits a negative and significant impact on ROE in both models. This finding is supported by studies such as that by Wang et al. (2021), which highlighted that higher energy consumption can increase operational costs and reduce profitability, especially when energy efficiency measures are not effectively implemented. NACAC (Natural Capital Cost) shows an insignificant impact on ROE in both models. This result suggests that while natural capital costs are important for environmental sustainability, they may not directly influence short-term financial performance metrics like ROE. Studies like those reviewed by Williams et al. (2023) suggest that the economic valuation of natural capital remains challenging to integrate fully into financial performance metrics.

Table 7: Summary of OLS and FGLS results

Variable	Negative/ Positive	Significant/ Insignificant	Decision
ENINR	Positive	Significant	Accept (Positive Impact)
ENEXR	Positive	Significant	Accept (Positive Impact)
ENEUSA	Negative	Significant	Accept (Negative Impact)
NACAC	Negative	Insignificant	Reject (No Significant Impact)
EMIIN	Negative	Significant	Accept (Negative Impact)
WATUS	Positive	Insignificant	Reject (No Significant Impact)
CAREM	Negative	Significant	Accept (Negative Impact)

EMIIN (Emissions Intensity) demonstrates a negative and significant impact on ROE. This aligns with findings from various studies that emphasize how high emissions intensity can lead to regulatory costs, reputational risks, and operational inefficiencies that negatively affect financial performance (Bendig et al, 2023). WATUS (Water Usage) shows an insignificant impact on ROE in both models. This suggests that water usage management, while crucial for sustainable operations, may not significantly affect immediate financial performance measures like ROE. Research such as that by Zhou et al. (2022) indicates that the financial impact of water management practices often manifests through broader operational efficiencies rather than direct impacts on financial ratios like ROE. CAREM (Carbon Emissions) exhibits a negative and significant impact on ROE. This finding is consistent with studies indicating that higher carbon emissions per revenue can lead to higher costs associated with carbon taxes, compliance measures, and customer demands for sustainability (e.g., Bansal and Clelland, 2004).

5. CONCLUSIONS AND RECOMMENDATIONS

The research investigates the relationship between Environmental Management Accounting (EMA) practices in improving the financial performance of wooden furniture manufacturing. Based on the findings of the study, it was overserved that the Environmental Investment Ratio (ENINR) and Environmental Expenses Ratio (ENEXR) show positive impacts on Return on Equity (ROE), suggesting that firms investing in environmental initiatives and allocating higher expenses to environmental management tend to achieve better financial performance. However, energy usage and Natural Capital Cost (NACACAC) have negative impacts, as higher energy consumption can increase operational costs and reduce profitability. High emissions intensity can lead to regulatory costs, reputational risks, and operational inefficiencies, while water usage management may not directly affect ROE. Carbon emissions have a negative impact on ROE, as higher emissions per revenue can lead to higher costs. From the above findings, the study made the following recommendations:
- Increase investments in green technologies and sustainable practices to enhance financial performance of the firm
- Allocate sufficient resources to environmental management activities, as indicated by the Environmental Expenses Ratio (ENEXR)
- Adopt energy-efficient technologies and practices to mitigate the negative impact of high energy usage on financial performance

- Integrate Natural Capital Costs (NACAC) into long-term strategic planning for overall sustainability and operational efficiency
- Prioritize reducing emissions intensity (EMIIN) to avoid regulatory costs and reputational risks
- Optimize water usage practices to contribute to broader operational efficiencies and sustainability goals
- Focus on reducing carbon emissions (CAREM) to lower costs associated with carbon taxes and compliance measures.

The continuous discourse surrounding Environmental Management Accounting Practices (EMAPs) and their impact on financial performance in economically disadvantaged countries, including South Africa, highlights many key concerns. These include the accessibility of EMA specialists, financial capital, and reliable environmental data. Hence, it is crucial to propose more research to determine the obstacles to the adoption of EMA in chemical and related companies within the identical sector.

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