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UNIVERSITY OF GHANA
(College of Humanities)

ENVIRONMENTAL MANAGEMENT ACCOUNTING AND ENVIRONMENTAL PERFORMANCE: STRATEGIC DRIVERS, ENABLERS AND MEDIATING ROLES

BY

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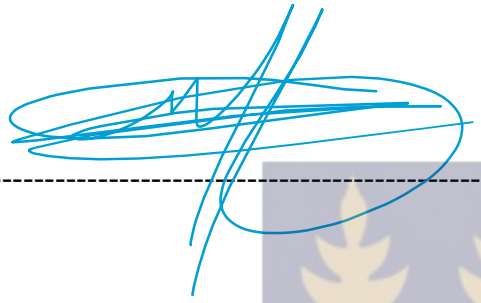
THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF DOCTOR OF PHILOSOPHY IN ACCOUNTING DEGREE

JULY 2025

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DECLARATION

I, the undersigned, do hereby declare that this thesis is the result of my own original research and has not been submitted by me or any other person for the award of a degree in any university. All references cited in this thesis have been duly acknowledged. I bear the responsibility for any errors, omissions and lapses that might appear in this thesis.



22nd July, 2025

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CERTIFICATION

I, the undersigned, do hereby certify that this thesis was supervised in accordance with the guidelines laid down by the University.



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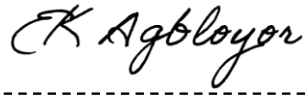


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DEDICATION

This work is dedicated to my precious mother, Hajia Abiba Akormondji, who has been an inspiration and a pillar in this educational journey. May Allah continue to bless her with a long life and good health. An equal weight of dedication goes to my amiable late father, Mr Alaiku Tossa.

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LIST OF ABBREVIATIONS

CMA	Carbon Management Accounting
COMP	Competitive Advantage
EMA	Environmental Management Accounting
EP	Environmental Performance
EPA	Environmental Protection Agency
FOLU	Forestry and Other Land Use
GHG	Greenhouse gas
GHRM	Green Human Resource Management
IPPU	Industrial Products and Product Use
MEMA	Monetary Environmental Management Accounting
PEMA	Physical Environmental Management Accounting
PLS	Partial Least Square
SEM	Structural Equation Model
VIF	Variance Inflation Factor

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ABSTRACT

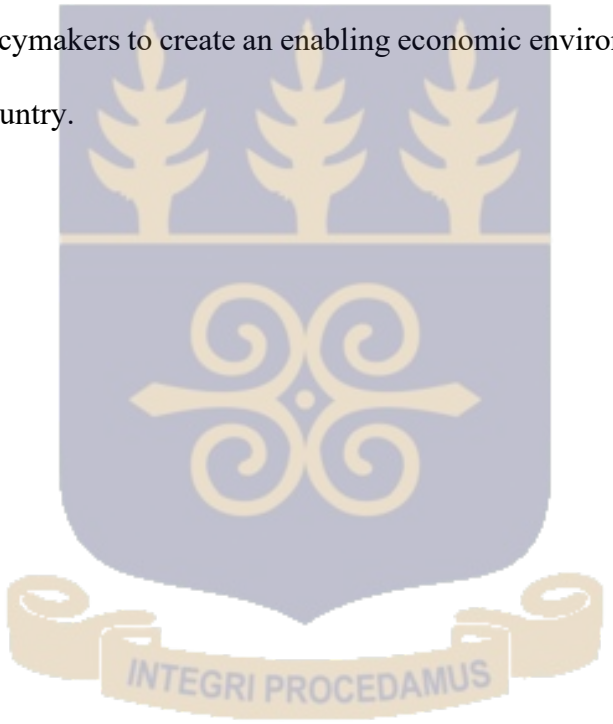
The study investigates the integration of Environmental Management Accounting into the functional-level environmental strategies and strategic outcomes of firms operating in environmentally sensitive sectors of Ghana. It specifically ascertains the mediating role of Environmental Management Accounting (EMA) in the relationship between Green Human Resource Management (GHRM) and Environmental Performance (EP). Besides, the study examines the impact of EMA on competitive advantage and EP. The sample comprises firms operating in the energy, manufacturing, transportation and waste management sectors. Using the Partial Least Squares Structural Equation Model (PLS-SEM) on firm-level data, the results reveal that EMA complementarily mediates the relationship between GHRM and EP, with physical EMA contributing more significantly than Monetary EMA to the total effect of GHRM on EP. This underscores the critical role of physical EMA in translating GHRM into improved EP. Furthermore, while physical EMA enhances competitive advantage, monetary EMA does not, and competitive advantage does not mediate the EMA-EP relationship. This finding suggests EMA can lead to improvements in EP independently of competitive gains.

As a complement to the two quantitative papers above, the third paper of the thesis follows a qualitative research method relying on an exploratory case study of two power-generating firms (via 15 interviews with 24 senior managers). It assesses the motivation for CMA practices, carbon management strategies and the carbon performance of the firms. The result reveals that Carbon Management Accounting (CMA), a specific type of EMA, is driven by regulatory pressures, cost reduction, and the desire for competitive advantage. Institutional factors like debt finance and government ownership further influence CMA adoption. Both firms resorted to compliance strategies in an attempt to improve carbon performance.

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The thesis contributes to the literature by focusing on how functional-level strategies, rather than corporate strategies, interrelate to improve environmental outcomes. It also demonstrates the differential effects of the components of EMA in influencing these environmental outcomes, an area underexplored in the literature.

Regarding policy implications, the study calls on policymakers to promote GHRM in organisations but give preference to PEMA tools and technologies amid resource scarcity. It further encourages policymakers to create an enabling economic environment that attracts eco-investments into the country.



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CHAPTER ONE

Introduction

1.1 Background of the Study

There is unprecedented pressure on organisations to improve their environmental performance (EP) by aligning their operations to global ecological goals (Liu & Zhang, 2022; Zatini, Porta, & Za, 2025). EP refers to the outcome of an organisation's efforts towards reducing its impact on the ecology. It seeks to minimise pollution and resource depletion (Singh, Chen, Giudice, & El-Kassar, 2019) through using biodegradable materials in products, minimal water and energy consumption, and waste reduction (Ong, Kasbun, Abdul Rahman, Meero, & Teh, 2022). Achieving higher EP supports the Sustainable Development Goals (SDGs), especially SDG 12, dealing with responsible consumption and production and SDG 13, calling for climate action.

Irresponsible production results in air, water, and soil pollution. Air pollution is the most destructive of all forms of pollution, and it caused a global mortality of 8.1 million people in 2021 and has contributed significantly to climate change over the years (WHO, 2025; Health Effects Institute, 2024). Low and middle-income countries are the most impacted due to weak regulations, economic vulnerability, and limited access to clean technologies (Forastiere, Orru, Krzyzanowski, & Spadaro, 2024; World Bank, 2023). The devastating impact of pollution places a necessity on all firms to boost their EP to protect humanity, especially vulnerable people.

Firms deploy various means to improve EP, but research indicates that the long-term success of companies depends on strategies that give credence to environmentally sustainable economic activities (Hart S. L., 1995; Hart & Dowell, 2011) that are driven by accurate data. Strategies are hierarchically classified into corporate strategy, business strategy and functional strategy (Wheelen & Hunger, 2012). Corporate strategy relates to the overarching direction of a company "toward

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growth and the management of its various businesses and product lines" (Wheelen & Hunger, 2012). Business strategy occurs at the business unit or product level. It is concerned with working towards a "competitive position of a product or service in a specific industry or market segment served by the business unit". Finally, a functional strategy is implemented in the functional areas of a business unit (i.e., HR, research and development, finance, marketing, etc.). It is undertaken to realise "corporate and business unit objectives and strategies by maximising resource productivity". It deals with "developing and nurturing a distinctive competence to provide a company or business unit with a competitive advantage" (Wheelen & Hunger, 2012). It is therefore relevant to assert that strategies at the hierarchy of a business unit seek, among other things, to provide a competitive advantage to the business (Porter & van der Linde, 1995; Porter M. E., Competitive Strategy, 1980).

Functional environmental strategies like green human resource management (GHRM) and competitive advantage (COMP) enable companies to enhance EP, leading to cleaner air and soil, safer water, healthier communities (Landrigan, Fuller, & Acosta, 2018) and sustainable development. EMA is a strategic tool that nourishes these strategies with timely data for decision-making (Liu & Zhang, 2022). The importance of human resources (HR) in strategy conceptualisation and implementation cannot be overemphasised (Hart S. L., 1995; Porter M. E., 1990; Porter M. E., 1998; Shah & Soomro, 2023). For firms, strategies cannot thrive without competent HR to drive their implementation and continuous improvement (Bombiak, 2019). Strategies are conceptualised, implemented, monitored and reviewed by humans. Regardless of the level of automation or technology involved in this process, the success or failure of strategies depends on people. Bombiak (2019) affirms that sustainable business strategies are contingent on the availability of competent staff, whose skills are continuously developed, to implement the principles. The integration of environmental sustainability into HR policies is GHRM (Liu & Zhang, 2022).

According to the Natural Resource-Based View (NRBV), corporations achieve sustainable environmental performance through pollution prevention, product stewardship and sustainable

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development (Hart S. L., 1995; Hart & Dowell, 2011). To prevent pollution, employees are trained in sustainable practices and environmental management. Moreover, in product stewardship, GHRM backs the development of teams from different functional units to design eco-friendly products and processes. Finally, with sustainable development, GHRM promotes innovation and collaboration to manage global sustainability challenges (Hart S. L., 1995). It is therefore not surprising that GHRM has gained recognition as a crucial environmental strategy for companies in which the HR departments play a major role in organisational sustainability (Molina-Azorin, Maria, Juan, Jorge, & Eva, 2021; Bombiak, 2019). Molina-Azorin, et al. (2021) posit that GHRM is both a means to achieve a company's environmental strategic objectives and an end. As an end, it inculcates into the human resource management practices the philosophy of environmental sustainability to promote the economic, physical, and social well-being of employees in the long term. As a means, it facilitates the alignment of the actions of employees towards the attainment of the environmental goal.

Additionally, NRBV posits that integrating environmental sustainability into corporate strategies enables firms to achieve COMP. In the context of environmental sustainability, COMP refers to a unique capability and strategy that enables a firm to outperform its rivals while achieving environmental, social and economic goals (Hart S. L., 1995). There exists cost-leadership COMP and product differentiation COMP (Porter M. E., 1998). In pursuing corporate environmental sustainability, resource conservation, waste reduction, and recycling, minimise costs, which may engender cost-leadership COMP. Products can also be differentiated based on superior environmentally sustainable characteristics to gain COMP (Hart S. L., 1995).

Furthermore, the success of environmental strategies hinges on the possession and optimal utilisation of monetary and physical information **for** decision-making (Liu & Zhang, 2022; Qian, Burritt, & Monroe, 2010; Qian, Hörisch, & Schaltegger, 2018). As a strategic tool, EMA provides information by facilitating the measurement of physical material and the cost of the environmental footprint of companies. Examples of EMA tools are Carbon Management Accounting (CMA) for measuring

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greenhouse gas (GHG) emissions, Material Flow Cost Accounting (MFCA) for measuring the flow of physical material and money in the life cycle of a product (Qian, Hörisch, & Schaltegger, 2018), and Eco-Investment Accounting to assist prospective investors with environmental metrics information in financial analysis (Schaltegger & Burritt, 2017). EMA equally enhances eco-control, which enables the implementation of environmental strategies. With the help of EMA, environmental auditing is carried out to independently provide assurance on EP (Qian, Hörisch, & Schaltegger, 2018).

Apart from strategies, in recent times, the strengthening of regulation has gained prominence as a means of pressuring firms to reduce or eliminate environmental degradation resulting from their operation (Zatini, Porta, & Za, 2025). Where such legal obligations do not exist, voluntary disclosure is undertaken as a legitimacy-seeking policy (Qian, Burritt, & Monroe, 2010). Some staunch critics argue that stiff environmental regulations discourage innovation and impede competitive advantage (Adler, 2000; Hahn, 1990; Lomborg, 2021). Furthermore, regulation increases compliance costs, creates entry barriers and distorts market-based solutions (Yandle, 1989). For these scholars, a trade-off exists between stiffer regulation and the economic performance of businesses. This implies that the tougher the regulations on the ecology, the lower the economic gains accruing to firms.

Contrary to the above, Porter and Van der Linde, (1995) support tougher regulation, arguing that tightening environmental regulations encourages firms to devise innovative strategies to comply, reduce costs and gain COMP. Properly crafted and more stringent environmental regulations actually benefit firms that devise better strategies. Porter & Van der Linde, (1995) added that the more stringent the regulation, the greater the inducement to improve environmental strategies to achieve greater competitiveness and firm environmental performance. The interest in regulating pollution has manifested in a significant concentration of research on regulation and disclosures and their effects on corporate environmental practices and performance (Nartey, 2018; Burritt, Schaltegger, & Zvezdov, 2011; Bui & Fowler, 2019; Porter & van der Linde, 1995)

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1.2 Problem Statement

As part of the measures aimed at promoting economic gains while ensuring environmental sustainability, Zatini, et al. (2025) suggest that researchers should be more interested in the underlying strategies within an organisation that drive sustainability. Unfortunately, few studies exist on the connection between organisational sustainability strategies and EP. Existing research on the linkage among environmental strategies, competitive advantage and firm performance focused unduly on corporate-level strategy (Bansal & Roth, 2000) and business unit-level strategy (Ismail, Rose, Abdullah, & Uli, 2010; Bui & Fowler, 2019) leaving functional-level strategy with explorable research opportunities.

Within the functional level strategy, the existing gaps are being filled with studies about green supply chain management, green innovation, green marketing and environmental management systems. Research has shown how ecological supply chain strategies reduce cost, provide COMP and improve performance (Zhu, Sarkis, & Lai, 2007; Rao & Holt, 2005). Besides, scholars have proved that functional area strategies like research and development (R&D) drive innovation and performance (Wang, 2019; Chen, Lai, & Wen, 2006). In addition, research has equally demonstrated how environmental strategies in marketing improved customer loyalty, increased brand reputation, and firm performance (Leonidou L. C., Leonidou, Fotiadis, & Zeriti, 2013; Leonidou, Leonidou, & Kvasova, 2010). Another functional area that has been studied vis-à-vis how it improves environmental and financial performance is the environmental management system (Melnyk, Sroufe, & Calantone, 2003). The research vacuum is in assessing the deployment of EMA into functional strategies to drive, not just enable, COMP, leading to improved EP (Zatini, Porta, & Za, 2025). This thesis addresses this gap.

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GHRM supports the implementation of all other strategies within an organisation. None of the hierarchies of strategy can thrive without GHRM because it provides the relevant competence relating to their implementation (Bombiak, 2019). The critical role of GHRM justifies the need for research on the impact of functional-level strategies on EP to focus on GHRM (Aftab, Abid, & Cucari, 2022). More importantly, research on GHRM and EP needs to consider the mechanisms through which GHRM impacts EP. One such mechanism is EMA. First, there is limited empirical evidence on EMA's mediating role in the relationship between GHRM and EP. This integration is essential because EMA provides both financial and non-financial ecological data that enhances decisions relating to sustainability initiatives promoted by GHRM (Liu & Zhang, 2022). It enables the quantification of the financial and environmental impact of eco-friendly behaviour induced by GHRM. This assessment allows a timely review of the GHRM strategies for a decision to be taken on their enhancement (Renwick & Maguire, 2013) in ensuring the achievement of EP. Therefore, this study, relying on NRBV and stakeholder theory, fills the gap by assessing the mediating role of EMA on the relationship between GHRM and EP.

Again, theoretically, the importance of EMA is increasingly interpreted through the NRBV. Scholars propose that EMA can serve as a valuable, firm-specific capability that supports sustainable COMP, consistent with NRBV principles. Nevertheless, a notable gap continues to exist within this body of literature. Existing empirical studies, while affirming EMA's beneficial effect on COMP (Rahman et al., 2021; Dunk, 2007), often conceptualise EMA as a unified construct without differentiating between its two fundamental elements. EMA is made up of two distinct parts: Monetary EMA (MEMA), which focuses on tracking environmental-related costs, and Physical EMA (PEMA), which monitors material and energy flows (Liu & Zhang, 2022). Whether these components contribute differently to COMP and environmental performance (EP) remains unexamined. From a managerial perspective, this distinction holds practical significance, particularly when navigating resource allocation decisions. If one component is the actual driver of COMP and EP, it should be prioritised strategically as a capability. Conversely, if not, it may be treated merely as an operational cost incurred for compliance reasons.

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Moreover, the NRBV outlines a specific strategic sequence: environmental capabilities should not only generate competitive advantage but also leverage that advantage to drive ongoing improvements in EP, indicating a mediated relationship (Hart & Dowell, 2011). Although separate studies have shown that EMA positively affects both COMP (Rahman et al., 2021; Dunk, 2007) and EP (Ong et al., 2022; Deb, 2023; Abdul Rasit et al., 2023; Hasan et al., 2024), it is still unclear whether these outcomes are causally linked or simply coincidental. Examining the integrated pathway—EMA→COMP→EP—would offer empirical evidence to assess whether EMA can be reconceptualised as more than just an information tool, but rather as a strategic capability (Zatini et al., 2025), in alignment with Hart's (1995) NRBV framework. For practitioners, such evidence is essential to justify strategic investment in EMA systems and to shift their role from compliance-oriented accounting practices to core elements of a sustainable competitive strategy.

Finally, the most serious of all types of pollution is air pollution (Manisalidis, Stavropoulou, Stavropoulos, & Bezirtzoglou, 2020; World Bank, 2023) and carbon emission is the worst air pollutant because of its causal link to climate change (IPCC, 2021). Due to the grave impact of climate change on livelihood, governments are tightening regulations and introducing schemes on carbon emissions. Besides, scholars have advocated that studies within the broader scope of EMA should focus more on CMA to address the challenges of the lack of standardised methods for measuring emissions, disclosure and managing greenhouse gas emissions (Changalima, Rutatola, & Ntangeki, 2025; Tuesta, Cristina, & Vicente, 2021; Sitompul, Suroso, Sumarwan, & Zulbainarni, 2023; Prajogo, Murwaningsari, & Mayangsari, 2023). As a result, studies have been conducted on measuring emissions and the disclosure of CMA practices (Kazemian, et al., 2022; Gulluscio, Puntillo, Luciani, & Huisingh, 2020). However, these works did not explore how CMA supports functional environmental strategies to boost carbon-related EP. Therefore, in line with the integration of EMA into functional-level strategies to enhance EP, this aspect of the thesis narrows down to how CMA (a specific component of EMA) relates to carbon management strategies to reduce carbon emissions (as a type of EP). Theorising based on the natural resource-based view, institutional theory, and stakeholder theory, this section of the thesis focuses on specifics to provide an in-depth understanding of the role of EMA in improving EP.

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1.3 Objectives of the Study

The purpose of this study is to provide insight into the integration of EMA into business environmental strategy to enhance EP. The specific objectives are to:

i. Examine the mediating role of EMA in the relationship between GHRM and EP.

ii. Ascertain the mediation of competitive advantage in the EMA – EP relationship

iii. Explore how CMA drives carbon management strategies to enhance EP.

1.4 Significance of the Study

The thesis provides empirical evidence that supports Sustainable Development Goal (SDG) 12 (responsible consumption and production) and SDG 13 (climate action) by linking EMA to corporate strategies and strategic outcomes. SDG 12 promotes sustainable use of resources, waste reduction and cleaner production. The thesis indicates that linking EMA to corporate strategies helps to quantify sustainable efforts (i.e. measuring eco-efficiency metrics), optimise resource consumption (waste reduction), and adopt cleaner production methods. EMA equally fosters transparency through the disclosure of environmental data. Furthermore, SDG 13 seeks to mitigate climate change (by reducing greenhouse gas emissions) and promote adaptation to climate change. The thesis shows that linking CMA to corporate climate strategies enables firms to identify carbon-intensive activities and implement a low-carbon strategy to improve the carbon footprint of companies. It advocates for policies that promote cross-functional collaboration on environmental performance.

In terms of contribution to literature, the thesis shifts focus from corporate-level strategies to functional-level strategies (e.g., HR, accounting, sustainability) to reveal how departmental practices interrelate and impact COMP and EP. It advances theory by showing that Physical EMA (PEMA) more strongly mediates the effect of GHRM on EP than Monetary EMA (MEMA), a distinction unexplored in prior literature. While both PEMA and MEMA are EMA components, only PEMA significantly enhances COMP, although both improve EP. Additionally, the study isolates CMA from the broad EMA and illustrates how it drives the carbon strategy of acquiescence,

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leading to improved carbon performance. It indicates that apart from cost reduction, the quest for competitive advantage (a pervasive finding in literature), debt finance, and government ownership shape CMA adoption and carbon strategies and carbon performance—a novel contribution to sustainability accounting research.

1.5 Structure of the thesis

The thesis comprises five chapters dealing with three distinct but related papers. Chapter One introduces the thesis by indicating the background of the study, the statement of the problem, the objectives, the significance, and the structure of the thesis.

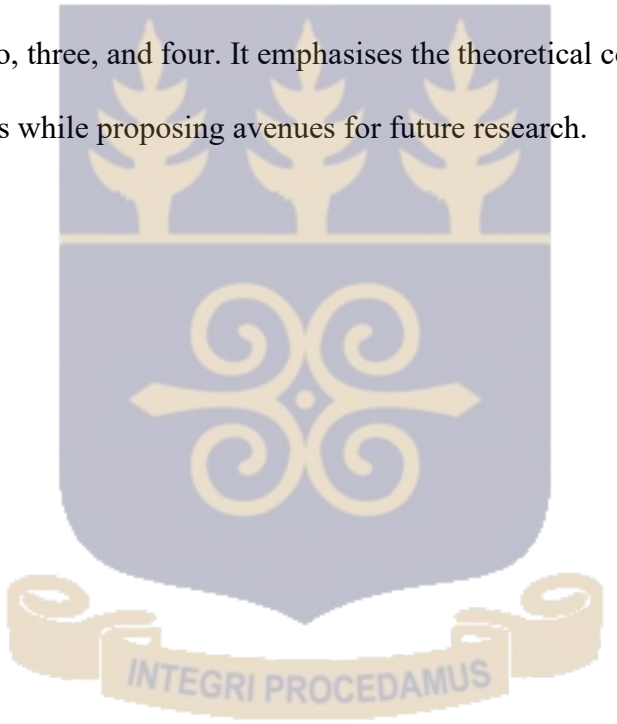
Chapter Two delves into the mediating role of EMA on the relationship between GHRM and EP. It investigates how GHRM enables the implementation of both monetary and physical EMA systems and how both EMA components translate GHRM's influence on EP. Responses from a survey of firms in high-polluting industries were analysed using a partial least squares structural equation model (PLS-SEM). The study shows that EMA partially and complementarily enhances the relationship between GHRM and EP.

After illustrating that investment in GHRM practices enhances EMA, which ultimately leads to greater impact of GHRM on EP, Chapter Three ascertains whether EMA can be repositioned from a mere technical tool to an environmental capability, in line with the NRBV, producing both COMP and EP. This study builds upon the previous by illustrating that even when both components of EMA are improved, it is only the physical EMA that serves as a strategic environmental capability leading to concurrent enhancement in COMP and EP. Monetary EMA does not affect COMP. Also, the study underscores the positive impact of both EMA components on EP, but it reveals that COMP is a co-occurring outcome of EMA, which does not mediate the relationship between EMA and EP.

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Chapter Four provides an in-depth understanding of how EMA leads to EP by focusing on a specific form of EMA (i.e. CMA) and EP (i.e. carbon performance). The study examined why firms in high carbon-emitting sectors engage in CMA practices, the carbon-related risks and opportunities they face, and how CMA practices link up with carbon management strategies to reduce carbon emissions. It highlights how GHRM practices enhance CMA, carbon strategies and carbon performance. The results show that institutional pressures and other factors motivated the sampled firms to engage in CMA practices. In addition, the firms pursued a compliance strategy heavily supported by CMA.

The final chapter consists of a summary of the thesis, and it provides policy implications of the findings in chapters two, three, and four. It emphasises the theoretical contributions of the thesis and ends with its limitations while proposing avenues for future research.



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CHAPTER TWO

The Mediating Role of Environmental Management Accounting in the Relationship Between Green Human Resource Management and Environmental Performance

Abstract

The study examines the mediating role of Environmental Management Accounting in the relationship between green human resource management and the environmental performance of firms operating in environmentally sensitive sectors of Ghana. The sample encompasses firms operating in the energy, manufacturing, transportation and waste management sectors. Data were analysed using the Partial Least Squares Structural Equation Modelling. In total, 196 firm-level responses, obtained from 397 individual responses, were analysed to reveal that green human resource management positively influences Environmental Management Accounting. Environmental Management Accounting also has a complementary mediation in the relationship between green human resource management and environmental performance, reinforcing its significance in ensuring that green human resource management contributes to environmental performance. Regarding the differential impacts of the components of Environmental Management Accounting, the results show that physical Environmental Management Accounting contributes more to the total effect of green human resource management on environmental performance than monetary Environmental Management Accounting. Examining the mediating role of Environmental Management Accounting enhanced the understanding of the mechanism by which green human resource management impacts environmental performance. This result, ensuing from interdisciplinary (Human Resource, Accounting and Environmental Science) variables, underscores the interdependence of functional organisational strategies in achieving corporate environmental goals. The study recommends that policymakers carry out green human resource management with Environmental Management Accounting effectively and cohesively to enhance environmental performance.

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2.1 Introduction

Like many Sub-Saharan African countries, firms operating in Ghana are increasingly pressured to improve EP by reducing environmental pollution, which adversely impacts ecosystems, public health and economic development (World Bank, 2020). Water pollution, soil pollution, and air pollution are the most pervasive. Plastic pollution, estimated at 1.1 million tonnes annually, is one of the leading causes of surface water pollution in urban areas (Ghana National Plastic Action Partnership, 2020). Other surface water pollutants include heavy metals, chemicals, organic substances, suspended solids and sediment (Ghana Water Company Limited, 2021; Anoyege & Alatinga, 2025). Of the country's rivers, 60% are polluted, with Densu, Ankobrah and Pra being highly affected (EPA, 2017). In urban areas, 30% of groundwater sources are polluted because of poor waste management and sanitation (Ghana Water Company Limited, 2021). Industrial wastewater amounting to 10,000 cubic metres is discharged into waterbodies daily, increasing the level of pollution (EPA, 2017). The World Health Organisation attributes 70% of waterborne diseases to polluted water (WHO, 2022) and the economic impact of water pollution is estimated at $400 million annually in healthcare costs, lost productivity, and environmental damage (World Bank, 2020).

Furthermore, poor waste management, agriculture and mining result in soil pollution. Starting with waste management, an annual average of 5 million tonnes of waste is generated in Ghana, comprising solid waste from households and institutions, plastic waste and hazardous waste (World Bank, 2020; EPA, 2017). Of the total waste generated in the country, a national average of 40% is collected, while a collection rate of 80% occurs in urban areas (EPA, 2017). Collected wastes are conveyed to landfill sites, while uncollected wastes are dumped in the open or burned. It is reported that many landfills are poorly managed, leading to leachate contamination of soil and groundwater. Open dumping and burning also pollute the soil and air. Recycling and production of fertilisers from organic waste are at a negligible scale (World Bank, 2020; EPA, 2017). With regards to the contribution of agriculture to land pollution, the clearing of forests for farming exposes soil to erosion, leading to increased loss of topsoil and sedimentation. A total of 35 tonnes of soil loss occurs

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annually, and the prime contributor is agricultural activities (World Bank, 2020). Agrochemicals and improper disposal of agricultural waste also contaminate the soil (Afele, Nimo, Lawal, & Afele, 2022). Around 7000 metric tonnes of pesticides and 400,000 metric tonnes of fertiliser are used annually in Ghana (MOFA, 2021). Ghana loses $1.2 billion annually in agricultural productivity because of soil degradation (World Bank, 2020). Finally, mining is a major contributor to land degradation in Ghana, with a total of 1.4 million hectares of land degraded due to illegal mining (EPA, 2017). The World Bank pegs the annual degradation of land in Ghana to 28,000 hectares (World Bank, 2020). In the dominant mining regions of Ashanti, Western and Eastern, as much as 60% of forest cover is lost to legal and illegal mining. Mining is responsible for a $2.3 billion loss of annual agricultural productivity and environmental damage (World Bank, 2020).

In Ghana, air pollution is primarily caused by emissions from industries and vehicles, dust, and the burning of biomass and waste. It is more severe in urban areas like Accra, Kumasi and Cape Coast than in rural areas (WHO, 2016). For example, in 2024, although the national mean concentration of fine particulate matter with a diameter less than 2.5 ($PM_{2.5}$) was 31 µg/m³ (far above the WHO guideline of 10 µg/m³), Accra recorded 74 µg/m³, Kumasi had 111 µg/m³, and Cape Coast witnessed 71 µg/m³ of $PM_{2.5}$ (IQAir, 2024). Ghana was adjudged the 14th (out of 138) most polluted country in the 2024 global rank of air pollution (IQAir, 2024). According to the WHO, air pollution was responsible for the premature death of 28,000 people in Ghana in 2012 (WHO, 2016) and it is estimated that the cost of air pollution in Accra and Kumasi averages $ 264 million per year (World Bank, 2021).

Faced with this challenge, Ghana has intensified efforts to tackle environmental pollution through policy, technological interventions, collaboration with local and international stakeholders and public awareness campaigns (World Bank, 2020; GSS/EPA, 2020). Over 70 legislations and policies exist to deal with the menace of air pollution, water pollution, soil pollution, plastic pollution and e-waste (GSS/EPA, 2020). Ghana also plays an important role in the international collaborative efforts to

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combat pollution. For example, the country is a signatory to many international and regional protocols and agreements aimed at addressing pollution. These include the Paris Agreement, the Stockholm Convention on Persistent Organic Pollutants and the Bamako Convention, to mention but a few (EPA, 2022). Concerning technological interventions, there has been investment in advanced pollution monitoring systems (i.e. real-time air quality monitoring stations in Accra, Kumasi and Tamale), cleaner production (e.g. wastewater treatment plants) and the establishment of plastic recycling plants (Ministry of Energy, 2022; World Bank, 2020). Finally, the EPA collaborates with NGOs and other organisations to educate people about the risks of pollution and the ways to reduce pollution (EPA, 2017).

The efforts to combat pollution are neither confined to Ghana nor to a particular government. Corporations are roped in through legal pressure (Qian, Burritt, & Monroe, 2010; Qian, Burritt, & Monroe, 2018; Porter & van der Linde, Toward a New Conception of the Environment-Competitiveness Relationship, 1995) or legitimacy-seeking (Qian, Burritt, & Monroe, 2010). Different schools of thought exist regarding the role of regulation in dealing with pollution. One of them states that there is a trade-off between tougher ecological regulations and economic performance. Stiff environmental regulations discourage innovation, impede competitive advantage, increase compliance costs, create entry barriers and distort market-based solutions (Adler, 2000; Hahn, 1990; Yandle, 1989). Conversely, Porter & van der Linde (1995) postulate that there is no trade-off between stiff regulation and economic performance. The more rigorous and properly crafted ecological regulations are, the more innovative management becomes to achieve greater competitiveness, economic performance and environmental performance. These two conflicting positions attracted significant research interest in ecological regulation and disclosure and their effects on corporate environmental performance (Nartey, 2018; Burritt, Schaltegger, & Zvezdov, 2011; Bui & Fowler, 2019; Porter & van der Linde, 1995). With the increasing incidents of greenwashing (Zatini, Porta, & Za, 2025), some scholars are calling for more research on the intrinsic environmental strategies businesses carried out to achieve ecological performance rather than

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focusing solely on regulations (Zatini, Porta, & Za, 2025; Hart S. L., 1995; Porter & van der Linde, Toward a New Conception of the Environment-Competitiveness Relationship, 1995).

Scholars have started to conduct more work on environmental strategies with more focus on corporate-level strategy and business unit-level strategy (Ismail, Rose, Abdullah, & Uli, 2010; Bui & Fowler, 2019; Bansal & Roth, 2000) than a functional level strategy. Concerning functional strategy, studies have been done on R&D, green marketing, green logistics, supply chain and environmental management systems performance (Wang, 2019; Chen, Lai, & Wen, 2006; Melnyk, Sroufe, & Calantone, 2003; Changalima, Rutatola, & Ntangeki, 2025) leaving GHRM with explorable research opportunities. The need to examine the mechanism by which GHRM impacts EP is a void that needs attention. More specifically, there is a paucity of research on EMA's mediating role in the relationship between GHRM and EP, focusing on the differential impacts of the components of EMA (PEMA and MEMA) on the relationship. This examination will enhance understanding of the mechanism through which GHRM impacts EP.

Whilst GHRM establishes the cultural and motivational foundation for environmental improvement, its direct translation into measurable EP remains conceptually incomplete. This gap underscores the critical mediating role of EMA. EMA serves as the essential mechanism that converts GHRM's ecological intents into actionable ecological data and systematic control. By providing both financial (MEMA) and physical (PEMA) information flows, EMA bridges the strategy–execution divide, enabling evidence-based decision-making that directly channels GHRM-driven initiatives into tangible performance outcomes (Liu & Zhang, 2022). This study explicitly examines this mediation to provide empirical insight into how the synergy between GHRM and EMA generates superior environmental performance, affirming that their integration is pivotal for translating human resource investments into ecological results.

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The purpose of this chapter is to examine the mediating role of EMA in the relationship between GHRM and EP in Ghana's high-polluting sectors. Specifically, it seeks to determine whether GHRM practices affect Monetary Environmental Management Accounting (MEMA) and Physical Environmental Management Accounting (PEMA). Because MEMA involves the financial estimation of environmental impacts, while PEMA focuses on quantifying environmental impacts in physical terms, the study examines the differential impacts of GHRM on MEMA and PEMA. Additionally, the study explores whether MEMA and PEMA mediate the relationship between GHRM and EP, and their differential effects on the mediation.

The study draws on Stakeholder Theory (Freeman, 1984) and NRBV Theory (Hart S. L., 1995) to hypothesise the associations among the variables. Stakeholder theory explains why it is hypothesised that EMA mediates the relationship between GHRM and EP, while NRBV indicates how such mediation occurs. Stakeholder Theory posits that organisations are integral parts of a network of relationships with various stakeholders who have the power to influence organisational behaviour. In this context, governments and employees are key stakeholders who shape environmental performance (Horisch, Schaltegger, & Freeman, 2020). Organisations will seek improved EP because of increasing government pressure to meet environmental standards (Prajogo, Murwaningsari, & Mayangsari, 2023; Krueger, Sautner, & Starks, 2020). GHRM enables organisations to bring their employees on board to enhance EP (Liu & Zhang, 2022) because employees are salient stakeholders (Horisch, Schaltegger, & Freeman, 2020). EMA allows the measurement of EP and provides feedback on GHRM practices to contribute to EP. From the perspective of NBRV, EMA provides the data and tools required to carry out pollution prevention, product stewardship, and sustainable development strategies (Hart S. L., 1995). It allows GHRM practices to be translated into measurable environmental targets against which progress towards improved EP can be gauged.

The hypotheses of this study are based on the premise that GHRM positively affects EMA (both MEMA and PEMA), and that EMA, in turn, positively influences EP. Previous research has

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established that EMA improves EP by providing firms with the information needed to make environmentally responsible decisions (Deb, Rahman, & Rahman, 2023; Le, Nguyen, & Phan, 2019). Furthermore, GHRM is expected to have a direct positive effect on EP, as organisations implementing GHRM are likely to develop a workforce that is more conscious of environmental sustainability, leading to improved EP (Nisar, et al., 2021).

To achieve these objectives, the study employs a quantitative approach, using survey data collected from firms in Ghana's high-polluting industries (power producers, agriculture, manufacturing, construction and management). Responses from a sample of 196 firms were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM). The result shows that GHRM positively affects EP, and this impact is mediated by EMA. Of the two components of EMA, PEMA contributes more to the total effect of GHRM on EP than MEMA.

This study contributes to the literature by improving the understanding of the mechanism through which GHRM impacts EP. It reveals that the HR function can incorporate green skills in staff to optimise EMA practices, which ultimately enhances EP. It further illustrates that a study involving interdisciplinary variables enables us to understand more comprehensively how functional strategies relate to a strategic tool within a company to achieve better EP. It also offers practical insights for policymakers and business leaders, highlighting the need for firms to adopt integrated approaches that combine GHRM and EMA to achieve sustainable development.

The chapter continues with section 2.2, which reviews theoretical and empirical literature on the subject. Section 2.3 elucidates the research methods, and Section 2.4 elaborates the empirical results. The final section deals with conclusions and policy implications.

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2.2 Literature Review

This section synthesises existing knowledge on GHRM, EMA and EP. It entails NRBV and Stakeholder Theory, which provide the foundations for the hypothesis that GHRM impacts EP. They equally explain EMA's mediating role in the association between GHRM and EP. This mediation role fills the void in the literature on integrating EMA into functional-level strategies like GHRM to achieve firms' environmental goals.

2.2.1 Environmental Pollution and Its Impacts

Environmental pollution is defined as "the contamination of the physical and biological components of the Earth/atmosphere system to such an extent that normal environmental processes are adversely affected" (UNEP, 2025). Based on the medium affected, pollution can be classified into air pollution, soil pollution, and water pollution. It is the largest cause of disease and premature death, affecting over 9 million people (The Lancet Commission on Pollution and Health, 2017). The impact of pollution is more serious in low and middle-income countries than in developed countries (Forastiere, Orru, Krzyzanowski, & Spadaro, 2024; World Bank, 2023). This is primarily because of health and economic vulnerability, weak environmental regulations and enforcement, and limited access to clean technologies (UNEP, 2020; The Lancet Commission on Pollution and Health, 2017).

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Starting with air pollution, the literature distinguishes between household air pollution and ambient air pollution (WHO, 2025). Both household and ambient air pollution caused 8.1 million deaths in 2021. Globally, household air pollution due to the reliance on polluting fuels and technologies for cooking stood at 38% of total air pollution, while ambient air pollution was 58% in 2021. The risk of death relating to air pollution is aggravated by the fact that 99% of the global population resides in affected areas (Health Effects Institute, 2024). Air pollution was the second leading risk factor for death in 2021 (Health Effects Institute, 2024).

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Water pollution is another significant challenge confronting living organisms. Key water pollutants are chemicals from agriculture, mining, industries and pharmaceuticals. Water pollution contributes to the scarcity of safe drinking water. The lack of water affected over 27% of the global population in 2021. Lack of access to potable water causes waterborne diseases and an estimated 485,000 deaths each year, the largest proportion of which occurs in developing countries (WHO, 2023).

Concerning soil pollution, over 100 million hectares of land are destroyed due to deforestation, urbanisation and overuse (UNCCD, 2025). Over 45% of degraded land occurred in Africa, and the continent is expected to lose more than 50% of its arable land by 2050 (AfDB, 2025). Land degradation is projected to cause a nearly 50% decline in sub-Saharan Africa's crop production and increase poverty and vulnerability (Katoch & Dahiya, 2024; AfDB, 2025).

Of the three types of pollution, research indicates that air pollution is the most destructive in terms of its impact on human health and climate change (Manisalidis, Stavropoulou, Stavropoulos, & Bezirtzoglou, 2020; World Bank, 2023). According to the World Health Organisation (WHO) the highest rate of morbidity and mortality in the world is associated with air pollution (Forastiere, Orru, Krzyzanowski, & Spadaro, 2024). Pollutants like nitrogen dioxide, carbon dioxide, fine particulate matter and ozone are responsible for serious cardiovascular and respiratory diseases and deaths (Manisalidis, Stavropoulou, Stavropoulos, & Bezirtzoglou, 2020). Many of these air pollutants are equally responsible for climate change, which has dire consequences (Prajogo et al., 2023; Elsayih et al., 2023; UNFCCC, 2016). Climate change has been linked to a 30-50% decrease in global agricultural productivity, with specific cases being a 36% reduction in maize yield in Italy and a 30% decline in fruit and forage harvests in France in 2003 (Sarkodie, Ahmed, & Owusu, 2022). In Africa, Kenya's 2000 floods affected over 800,000 people, leading to significant loss of life and property (Sarkodie, Ahmed, & Owusu, 2022).

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2.2.2 Environmental Management Accounting

EMA is the administration of financial and non-financial evidence relating to the environmental impact of a firm's operations to ensure that the firm is ecologically responsible (Zandi & Lee, 2019). Given that Freeman's (1984) stakeholder theory posits that different stakeholders require different information about a firm (Freeman, 1984; Schaltegger & Csutora, 2012), scholars (Liu & Zhang, 2022; Qian, Burritt, & Monroe, 2010) have categorised EMA into monetary environmental management accounting (MEMA) and physical environmental management accounting (PEMA) to meet the information needs of various stakeholders. MEMA relates to the ecological impact estimated in terms of money, and it satisfies the information requirement of stakeholders concerned about economic outcomes such as budgeting, cost-benefit analysis and profitability. Examples of such stakeholders are finance managers and investors. On the other hand, PEMA pertains to a firm's environmental impacts that are quantified in physical units, and it serves the needs of stakeholders (e.g. operations managers and regulators) prioritising ecological outcomes such as environmental efficiency and regulatory compliance. Accounting for both physical inputs (water, energy, and other materials) and physical output (like finished products, work in progress, waste and emissions) enables close monitoring of environmental targets (Zandi & Lee, 2019). Burritt, Hahn, & Schaltegger (2002) recommends that researchers decouple the two components of EMA because they are distinct but provide complementary information for better analysis. Additionally, Hart (1995) asserts that pursuing a long-term environmental gain may require short-term costs. In the short term, PEMA and MEMA may have a differential impact, justifying the need to separate them in analyses (Schaltegger & Csutora, 2012). For example, a firm seeking to increase long-term environmental benefits through afforestation (PEMA) may incur short-term costs (MEMA) of planting and nurturing trees. To underline the significance of incorporating environmental costs and benefits into the scope of management accounting and to highlight the incompleteness of conventional management accounting, proponents of EMA use descriptive terms such as 'comprehensive accounting', 'life-cycle costing, and 'full-cost accounting' (Liu & Zhang, 2022; Qian, Burritt, & Monroe, 2010).

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2.2.3 Green Human Resource Management

GHRM is a human resource philosophy, policy and practice that prioritises environmental sustainability in recruitment, selection, training and development, and compensation (Liu & Zhang, 2022). It entails practices such as education and training, rewards, empowerment of employees, manager involvement, and the employee life cycle (Shah & Soomro, 2023).

2.2.4 Environmental Performance

Environmental performance (EP) refers to the behaviour of a firm regarding the ecology, and it encompasses how the firm utilises resources to reduce pollution (Singh, Chen, Giudice, & El-Kassar, 2019) through practices like the use of biodegradable materials in products, reduction in energy consumption, waste reduction, and minimisation of environmentally harmful substances (Ong, Kasbun, Abdul Rahman, Meero, & Teh, 2022). Improved EP is achieved through strategies including pollution prevention, product stewardship and sustainable development (Hart & Dowell, 2011; Hart S. L., 1995).

2.2.5 Natural Resource-Based View

The Natural Resource-Based View (NRBV), propounded by Hart (1995), postulates that a firm can achieve competitive advantage and higher environmental performance by deploying three strategic environmental capabilities: pollution prevention, product stewardship, and sustainable development. These capabilities have a differential impact on environmental performance because they are heterogeneous, hierarchical and dynamic (Barney J. , 1991; Hart S. L., 1995; Teece, Pisano, & Shuen, 1997). Heterogeneous capabilities are the diverse skills, processes and knowledge developed over time within an organisation. Because these capabilities develop over time, they differ in maturity or integration and cause different impacts on environmental performance and competitiveness (Barney J. , 1991). Besides, dynamic capability relates to a “firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments” (Teece, Pisano, &

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Shuen, 1997). These capabilities evolve, so capabilities at different stages of evolution will have unequal impact on sustainability performance. Finally, hierarchical capabilities refer to a connection among capabilities such that basic ones (i.e. pollution prevention capabilities) provide the foundation upon which more complex or advanced capabilities (product stewardship and sustainable development) are built. This hierarchy also implies a differential impact on sustainability performance and competitiveness (Barney J. , 1991; Hart S. L., 1995) since a firm may have one or more types of capabilities that are more developed than others. GHRM cultivates employee environmental behaviour as a capability, monetary EMA promotes pollution prevention capabilities, while physical EMA fosters product stewardship capabilities (i.e. EMA comprises monetary EMA and physical EMA). Because GHRM and EMA promote distinct capabilities, their effects on environmental performance will differ based on a firm's position in the capability hierarchy. Therefore, testing their differential effects is theoretically relevant.

Furthermore, the three strategic capabilities in NRBV (Hart S. L., 1995) explain how EMA mediates the GHRM-EP relationship. First, pollution prevention relates to minimising waste and emissions at source and requires accurate measurement and monitoring of ecological impacts. This strategy saves the cost of installing and operating pollution control systems and increases productivity and efficiency. Efficient utilisation of inputs leads to less waste and lower cost of raw material and waste disposal. Using less material reduces the depletion of natural resources, which ensures sustainability. Additionally, pollution prevention allows for emission reduction far below regulatory thresholds, thereby reducing compliance costs (Hart S. L., 1995; Hart & Dowell, 2011). Reducing waste, emissions, and associated costs are examples of enhanced EP. GHRM practices such as green recruitment and training ensure that a firm possesses environmentally conscious staff with the appropriate competence and motivation to adopt pollution prevention measures (Liu & Zhang, 2022; Shah & Soomro, 2023) to increase EP. EMA assists in measuring and monitoring the quantum and cost of waste, emissions and resource use, thereby enhancing pollution prevention strategies (Zatini,

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Porta, & Za, 2025; Molina-Azorin, Maria, Juan, Jorge, & Eva, 2021). It translates employees' GHRM-driven actions into measurable environmental outcomes (EP).

Product stewardship (Hart & Dowell, 2011; Hart S. L., 1995) pertains to the need to minimise adverse environmental impacts of products throughout their lifecycle (i.e. from design to disposal). This requires collaboration among different functional strategies (HR, procurement and supply chain, operations, marketing, R&D, etc) (Hart & Dowell, 2011). In this regard, R&D may be preoccupied by eco-design while procurement and supply chain sources inputs from green suppliers (Shah & Soomro, 2023; Zhu, Sarkis, & Lai, 2007; Chen, Lai, & Wen, 2006). GHRM creates cross-functional green teams, enhancing cooperation among various employees on a common organisational environmental goal (Aftab, Abid, & Cucari, 2022). Through cross-functional cooperation among different departments, implementation gaps, including the need for more robust financial and physical data on material flows, waste and emissions, could be identified. In effect, EMA tools such as Material Flow Cost Accounting, Supply Chain Accounting, Lifecycle Costing, Supplier Audits, etc (Schaltegger & Burritt, 2017) can be deployed to deal with the gap. In addition, GHRM provides the relevant competence to employees to execute the EMA tools, fosters employee buy-in and forestalls their resistance.

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Finally, sustainable development entails creating long-term value by integrating economic, environmental and social goals into an organisation's strategy. It is the recognition of the link between material consumption and environmental degradation, and the necessity to ensure that resources are used in a manner that promotes continuous production into the future (Hart & Dowell, 2011; Hart S. L., 1995). Sustainable development requires long-term commitment and monitoring that GHRM fosters by instilling green norms and values into an organisation's culture (Molina-Azorin, Maria, Juan, Jorge, & Eva, 2021). Cultural imbibement of green values and norms in a firm is not enough to achieve sustainable development strategies; EMA ensures proper monitoring and evaluation and provides real-time feedback on progress towards sustainable development goals.

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In summary, the NRBV demonstrates that EMA mediates the relationship between GHRM and EP by quantifying waste, emissions and resource efficiency, monitoring and evaluating GHRM interventions and providing relevant feedback. The ensuing paragraphs illustrate the association among the variables from the perspective of Stakeholder Theory.

2.2.6 Stakeholder Theory

Stakeholder theory, introduced by Freeman (1984) and Freeman et al. (2010), consists of four principal ideas. First, an organisation is a network of relationships among stakeholders defined as "any group or individual who can affect or be affected by an organisation" (Freeman, 1984). Secondly, managers are responsible for creating value for stakeholders by aligning, as far as possible, the different and sometimes conflicting interests of stakeholders. The multitude of stakeholders that an organisation might associate with poses a challenge, and therefore, there ought to be prioritisation using stakeholder salience as a yardstick (Horisch, Schaltegger, & Freeman, 2020). Stakeholder salience entails criteria such as power, legitimacy, urgency, proximity, implied contract, risks, and vulnerability that are considered in deciding which stakeholders should be given preference over others. The third notion of the theory is the 'integration thesis', according to which ethics and business are inextricably intertwined. This is explained by Horisch, Schaltegger, & Freeman (2020) to mean that 'most business decisions also have an ethical content' so ethical decisions are an inseparable part of a business as a 'value-creating activity'. The final idea of the theory is that firms are established for purposes that extend beyond profit-making to ensure fruitful cooperation with stakeholders. Given the wide range of stakeholders (with different and sometimes conflicting interests), critics (Jensen, 2001) posit that stakeholder theory has a vague focus, leading to managerial confusion and inefficiency due to a lack of prioritisation.

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Linking stakeholder theory to environmental sustainability, under which EMA falls, Horisch, Schaltegger, & Freeman (2020) limits the focus by arguing that firms should prioritise stakeholders with whom they share substantial risks and those with whom they have '(implied) contracts.' The United Nations Environmental Programme also highlighted major stakeholders that ought to be prioritised by firms in matters of environmental sustainability. They are children and youth, farmers, indigenous peoples and their communities, local authorities, non-governmental organisations, the scientific and technological community, women and workers/trade unions (UNEP, 2024). Indigenous people are salient stakeholders because of their legitimate claim to land rights, and the threat of environmental degradation to their livelihoods and their advocacy power.

Drawing on the above, this work argues that regulators have the power to sanction companies that fail to adhere to regulatory requirements (Tang & Luo, 2014). Therefore, to remain in operational existence, high-polluting firms must aim at achieving higher EP. In addition, these firms must equally prioritise their workers as key stakeholders because of contractual relations and the risks they share. Fines, withdrawal of business certificates, bankruptcy and any other adversities suffered by firms undoubtedly affect workers (Tang & Luo, 2014). It is therefore appropriate to expect that companies in high-polluting industries will deliberately engage in GHRM as a functional strategy by recruiting, training, and rewarding their human resources based on ecological sustainability. EMA enables firms to meet stakeholder demands by quantifying environmental impacts. It also serves as a tool that translates GHRM into improved EP. It provides both financial and non-financial ecological data that improve decisions relating to sustainability initiatives championed by GHRM strategies (Liu & Zhang, 2022). Without EMA, timely data-driven feedback allowing continuous improvements in GHRM strategies for better EP of companies would not be possible. This section continues with definitions of variables and the establishment of relationships among them.

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2.2.7 Green Human Resource Management and Environmental Management Accounting

Although GHRM is often discussed within the human resource and strategic management literature, it also has clear relevance to the accounting and sustainability accounting literature. From an accounting perspective, GHRM plays a critical role in enabling EMA practices. Based on NRBV and Stakeholder Theory, this study postulates that GHRM significantly enhances the implementation and efficacy of EMA through several key mechanisms.

Firstly, GHRM practices such as green recruitment and training promote a workforce that is both competent and motivated to adopt pollution prevention measures (Liu & Zhang, 2022; Shah & Soomro, 2023). This necessitates organisations to implement EMA to accurately measure and monitor waste, emissions, and resource utilisation (Zatini et al., 2025; Molina-Azorín et al., 2021).

Secondly, GHRM facilitates cross-functional cooperation through the establishment of green teams (Aftab et al., 2022). Such collaboration helps identify information gaps, thereby necessitating the deployment of specialised EMA tools, such as Material Flow Cost Accounting, Supply Chain Accounting, and Lifecycle Costing (Schaltegger & Burritt, 2017). Furthermore, the role of GHRM in institutionalising sustainable values within organisational culture (Molina-Azorín et al., 2021) ensures employee commitment to EMA processes, overcoming potential resistance while enabling robust tracking of environmental objectives. It is therefore appropriate to conjecture the relationship between GHRM, MEMA and PEMA as follows:

H1a: GHRM will positively affect MEMA.

H1b: GHRM will positively affect PEMA.

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2.2.8 Environmental Management Accounting and Environmental Performance

Drawing from NRBV and stakeholder theory, one deduces that EMA significantly enhances EP through three key mechanisms. First, EMA improves pollution prevention by precisely measuring and monitoring waste, emissions, and resource use (Zatini et al., 2025; Molina-Azorin et al., 2021), enabling firms to reduce compliance costs and operational inefficiencies (Hart, 1995; Hart & Dowell, 2011). Second, EMA supports product stewardship by providing tools like Material Flow Cost Accounting and Lifecycle Costing (Schaltegger & Burritt, 2017), which help identify and address gaps in material flows and supply chain ecological impacts. Third, EMA ensures sustainable development by providing real-time feedback on sustainability goals (Molina-Azorin et al., 2021), enabling firms to align their long-term strategies with measurable outcomes. These functions underscore EMA's critical role in bridging stakeholder expectations, regulatory compliance (Tang & Luo, 2014), and operational sustainability, ultimately driving superior EP. Stakeholder Theory recognises that different stakeholders require different information.

Empirical research also confirms a positive influence of EMA on EP. For instance, Deb, Rahman, & Rahman, (2023) investigated the impact of EMA on the EP and financial performance of 323 manufacturing firms in Bangladesh using PLS-SEM. The results indicate that EMA is positively and significantly related to EP and financial performance. Similarly, Le, Nguyen, & Phan (2019) explored the factors that influence the application of EMA and the association between EMA and performance (both financial and environmental). In a sample of 418 firms in Vietnam, the analysis indicates that EMA positively and significantly impacts both EP and financial performance. It is thus relevant to conjecture that EMA positively affects EP, hence the following hypotheses:

H2a: MEMA will positively affect environmental performance.

H2b: PEMA will positively affect environmental performance.

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2.2.9 Green Human Resource Management and Environmental Performance

Following NRBV, it is plausible to state that GHRM significantly improves EP. First, GHRM practices like green recruitment and training develop ecologically conscious employees who implement pollution prevention measures like reducing waste and emissions and improving resource use (Aftab, Abid, & Cucari, 2022; Singh, Chen, Giudice, & El-Kassar, 2019). Second, GHRM engenders cross-functional collaboration through green teams, enabling coordinated product stewardship across departments to minimise environmental impacts throughout product lifecycles (Aftab, Abid, & Cucari, 2022).Third, GHRM inculcates long-term sustainability values in organisational culture, ensuring continuous commitment to environmental goals (Molina-Azorin et al., 2021). These GHRM interventions lead to measurable EP improvements (Schaltegger & Burritt, 2017; Zatini et al., 2025). Furthermore, stakeholder theory suggests that GHRM helps firms address regulatory and employee stakeholder concerns by aligning human resource practices with sustainability objectives (Horisch, Schaltegger, & Freeman, 2020).

Empirically, Asfahani (2023) examined the effects of GHRM on the EP of universities in a sample of 408 faculty and 58 non-faculty members of Saudi higher educational institutions. Using PLS-SEM for the analysis, the study found a significant and positive influence of GHRM on EP. Akin to this study is that of Aftab, Abid, & Cucari (2022) who analysed data from 410 manufacturing firms in Pakistan using PLS-SEM. The results support the fact that GHRM positively and significantly influences environmental performance. In a different setting involving hotels in Malaysia, Nisar, et al. (2021) collected data through a survey of 374 employees. The analysis performed using PLS-SEM revealed that GHRM plays a significant role in enhancing EP. It is therefore conjectured that GHRM positively affects EP.

H3: GHRM will positively affect EP.

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2.2.10 Mediation effect of EMA

EMA serves as a critical mediator between GHRM and EP through three mechanisms aligned with the NRBV (Hart, 1995; Hart & Dowell, 2011). First, in pollution prevention, GHRM develops ecologically competent staff through green recruitment and training (Liu & Zhang, 2022; Shah & Soomro, 2023), while EMA quantifies their impact by measuring waste and emissions reduction and efficiency of resource utilisation (Zatini et al., 2025; Molina-Azorin et al., 2021). Second, for product stewardship, GHRM fosters cross-functional collaboration (Aftab et al., 2022), with EMA providing tools like Lifecycle Accounting and Supply Chain Accounting to track environmental impacts of a product or service throughout its lifecycle and supply chain (Schaltegger & Burritt, 2017). Third, in sustainable development, GHRM fosters green norms and values (Molina-Azorin et al., 2021) to induce long-term commitment and monitoring, while EMA facilitates monitoring and evaluation of progress with real-time feedback for decision-making. Stakeholder theory further reinforces this mediation: EMA translates GHRM initiatives into measurable EP outcomes that satisfy regulatory pressure and employee needs (Tang & Luo, 2014; Liu & Zhang, 2022), ensuring continuous improvement through data-driven decisions. Thus, EMA bridges GHRM's behavioural interventions with tangible environmental gains. It is therefore conjectured that EMA will enhance the influence of GHRM on EP; hence, the following hypothesis:

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H4a: MEMA mediates the relationship between GHRM and EP

H4b: PEMA mediates the relationship between GHRM and EP

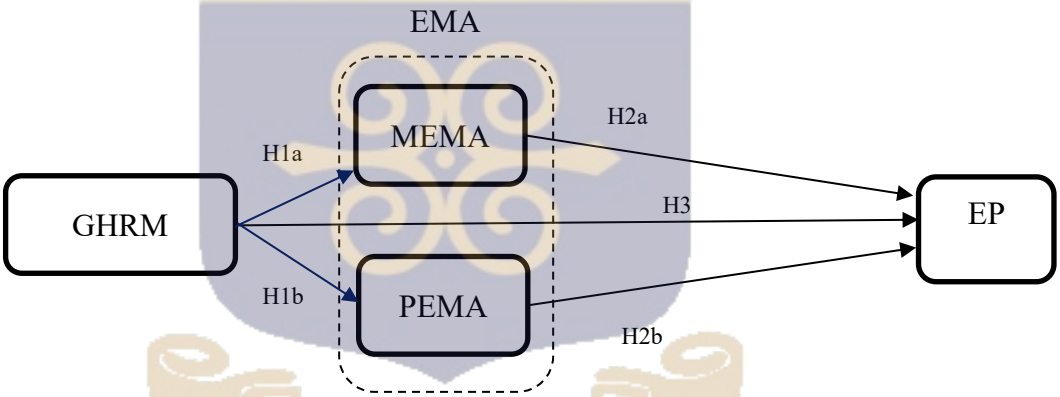
2.2.11 Conceptual Framework

The relationships among EMA, GHRM, and EP, as hypothesised, are presented in a conceptual framework displayed in Figure 2.1. The framework developed by the author is underpinned by NRBV and stakeholder theory. It is equally supported by empirical results from prior studies (Liu & Zhang, 2022; Aftab, Abid, & Cucari, 2022; Zatini, Porta, & Za, 2025; Deb, 2023).

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The framework indicates that the relationship between GHRM and EP is not solely a direct association, but it operates through EMA (i.e. GHRM → MEMA → EP and GHRM → PEMA → EP). This is a mediation in which GRHM impacts EMA, which in turn affects EP. The direct effect of GHRM on EMA is captured in hypothesis H1a, while its impact on PEMA is represented in hypothesis H1b. The direct effect of GHRM on EP is labelled hypothesis H3. In hypothesis H2a, the direct effect of MEMA on EP is displayed, while the direct impact of PEMA on EP is presented in hypothesis H2b. The indirect effect of GHRM through MEMA, referred to as hypothesis H4a, is the mediation of MEMA in the relationship between GHRM and EP. Hypothesis H4b also shows the mediation of PEMA in the relationship between GHRM and EP.

Figure 2.1: Conceptual Framework for the mediating role of EMA



Note. Author's own work (2025)

2.3 Methodology

2.3.1 Sampling

Firms in sectors known for high environmental degradation were purposively sampled for the study because these industries have the greatest potential to significantly reduce environmental degradation, resulting in maximum benefit per unit of effort. (Elsayih, Datt, Tang, Hamid, & Varua, 2023; Kazemian, et al., 2022; Jona & Soderstrom, 2023; IQAir, 2024; IPCC, 2021). Another justification for this choice is that high-polluting industries face the toughest regulatory pressure,

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which propels them to adopt strategies to improve EP (Tuesta, Cristina, & Vicente, 2021; UNEP, 2025). In Ghana, high-polluting industries include energy, agriculture, transportation, mining, waste management, and manufacturing (EPA, 2021). Apart from the mining industry, whose pollution is disproportionately driven by clandestine illegal miners, firms from all the other sectors were included in the sample.

Consistent with prior literature (Deb, Rahman, & Rahman, 2023; Le & Nguyen, 2018), 5 questionnaires were sent to firms operating in these industries, targeting chief executive officers, accountants, human resource managers, and other departmental managers. This is because these senior officers are directly connected to the implementation of functional and corporate strategies of businesses, and are appropriate participants (Deb, Rahman, & Rahman, 2023; Liu & Zhang, 2022). Moreover, using multi-source surveys to test hypotheses allows for triangulation of information and the avoidance of biases resulting from single respondents (Liu & Zhang, 2022). It is worth noting that in some firms, not all 5 questionnaires were accepted.

Following the above, 995 questionnaires were administered to 348 firms (within seven months) in Accra, Tema, Kumasi, Winneba, Takoradi, and Tamale. These locations were chosen because of the presence of the country's industrial zones and the hosting of the sampled firms. In total, 397 valid individual responses (representing 27.24%) were received from 196 firms (constituting 56.32% of firms). Studies on EMA have recorded diverse response rates. In a sample of the Vietnamese automobile industry, Le, Nguyen, & Phan (2019) had a 73% response rate, while the rate of response stood at 23.2% in the research of Ong, Kasbun, Abdul Rahman, Meero, & Teh (2022) conducted on chartered accountants in Malaysia. In s, Nartey (2018) obtained a response rate of 88.4% after sampling chartered accountants. It is therefore worth noting that the response rate of 27.24% (individual level) or 56.32% of firm responses falls within the range stipulated above, and it is therefore acceptable.

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To carry out firm-level analysis, an average of responses per firm was computed as recommended by Miao et al. (2012) leading to 196 firm-level responses being used in the analysis. This sample size is sufficient for analyses using PLS-SEM because PLS-SEM is capable of handling small sample sizes (Hair J. , Hult, Ringle, & Sarstedt, 2017a; Hair, Risher, Sarstedt, & Ringle, 2019) and many authors have indicated that in PLS, the minimum sample size can be as small as 20 (Palos-Sanchez, Martin-Velicia, & Saura, 2018; Ching & Newsted, 1999).

This study uses PLS-SEM (Smart PLS version 4) because the data is not normally distributed (Hair, Risher, Sarstedt, & Ringle, 2019). PLS-SEM was chosen due to its robustness to non-normality (Hair et al., 2019). Hair, et al. (2019) assert that PLS-SEM facilitates estimating "complex models with many constructs, indicator variables and structural paths without imposing distributional assumptions on the data". Besides, it is suitable for both causal explanations and predictions in estimating statistical models.

2.3.2 Assessment of Non-Response Bias and Common Method Bias

In consonance with the postulation of Wang (2019), this study assessed non-response bias using SPSS software by comparing the averages of responses of 50 early respondents (firm-level responses) against those of 50 late respondents. The result of the T-tests (shown in Table 2.1) indicates no significant difference, thereby confirming the absence of a non-response bias.

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Table 2.1: Assessment of Non-Response Bias

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
ME_MEMA - ML_MEMA	-0.002	1.573	0.222	-0.449	0.445	-0.008	49	0.994
ME_PEMA - ML_PEMA	-0.275	1.748	0.247	-0.772	0.222	-1.112	49	0.271
ME_GHRM - ML_GHRM	0.056	1.542	0.218	-0.382	0.494	0.257	49	0.799
ME_EP - ML_EP	-0.287	1.807	0.256	-0.800	0.227	-1.122	49	0.267

Note. Table 2.1 presents the result of the nonresponse bias assessment. ME_MEMA = Mean of MEMA indicators for early respondents and **ML_MEMA** = Mean of MEMA indicators for late respondents. **ME_PEMA** is the Mean of PEMA indicators for the early respondents, and **ML_PEMA** is the mean of PEMA indicators for the late respondents. **ME_GHRM** is the Mean of GHRM indicators for early respondents, and **ML_GHRM** is the mean of GHRM indicators for late respondents. **ME_EP** is the Mean of EP indicators for early respondents, and **ML_EP** is the mean of EP indicators for late respondents.
Source: Author's own construct (2025)

Following Kock *et al.* (2021), both procedural controls and statistical controls were deployed to deal with common method bias to ensure the validity and reliability of the survey. Commencing with the procedural controls, the instrument was designed to ensure the anonymity of respondents and to cater for the propensity of having socially desirable responses. Furthermore, a pilot survey was conducted on a sample of three firms in the waste management industry and one firm in the energy industry. This facilitated a discussion with respondents about the clarity of the statements in the questionnaire. Consequently, 5 out of 24 items in the questionnaires were rephrased because they appeared ambiguous. Additionally, the study prioritised psychological separation over methodological and temporal separations because it enabled the researcher to take away the attention of respondents from the causal association between independent and dependent variables to avoid favourable answers (Kock, Berbekova, & Assaf, 2021). Specifically, dependent and independent variables were placed in different parts of the questionnaires to achieve this objective.

With regards to the statistical controls, Knock (2015) suggests the use of the full collinearity test for the assessment of the existence of common method bias. If variance inflation factors (VIFs) are

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greater than 3.3 then there exists common method bias in the model. However, "if all VIFs resulting from a full collinearity test are equal to or lower than 3.3, the model can be considered free of common method bias" (Knock, 2015). As indicated in Table 2.2, the VIFs of all inner models are below 3.3, which suggests the absence of common method bias in the model.

Table 2.2: Statistical Control of Common Method Bias

Latent Variables Relationship	VIF
GHRM -> EP	2.075
GHRM -> MEMA	1.000
GHRM -> PEMA	1.000
MEMA -> EP	2.743
PEMA -> EP	2.584

Note. Table 2.2 presents the result of the common method bias assessment using VIF. **VIF** means variance inflation factor. **MEMA** is monetary environmental management accounting assessed with 8 indicators, **PEMA** is physical environmental management accounting assessed with 4 indicators, and **GHRM** indicates green human resource management, which is measured using 8 manifest variables. **EP** stands for environmental performance measured with 4 indicators.
Source: Author's own construct (2025)

2.3.3 Measurement of Constructs

The constructs were measured using questionnaires with statements ranked on a 7-point Likert scale, with 1 as the lowest score and 7 as the highest score. Rahman, et al. (2021) affirm the superiority of a 7-point Likert scale over the 5-point scale concerning indices such as respondent preference, discriminating power, reliability, and validity.

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EMA (consisting of PEMA and MEMA) and GHRM were measured by adopting the scale of Liu & Zhang (2022) and Ferreira, et al. (2010). MEMA comprises 8 statements, whilst PEMA is made up of 5 statements. Furthermore, GHRM entails 8 statements, whilst EP was measured by adopting the 4 statements from Wang (2019).

2.4 Empirical results

This section entails the demographic profiles of respondents and an assessment of the reliability and validity of the constructs. It also considers model performance and goodness of fit, and the testing of hypotheses.

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2.4.1 Demographic Profile

The sample consisted of 68.26% males and 31.74% females. This implies that the sample under study is dominated by males. This gender disparity is a concern when individual-level analyses are carried out. However, this is a firm-level study, so this concern may not arise.

Regarding age, 46.94% of respondents were below 35 years, and the remaining 53.06% were aged 35 years or above. This indicates that the sample has a relatively balanced age range, suggesting insight from both young and old workers. The excess of older workers over younger ones is not surprising because of the focus on senior management in the administration of questionnaires.

It is noticeable that 94.90% of the respondents possessed at least a bachelor's degree in a business-related field, chemistry, environmental science, engineering, and agriculture, while 5.10% had senior high school certificates. This implies that most respondents are highly educated, which corresponds with the level of education expected of senior management operating at functional strategic levels. The diversity of their field of study is an indication that GHRM and EMA require expertise from different disciplines for successful implementation.

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Finally, the firms operated in the agriculture (4.08%), energy (15.31%), waste (18.88%), transport (5.1%), and manufacturing (56.63%) sectors. This demonstrates that more responses came from the manufacturing sector than from all other sectors. It also reflects the diversity of companies (textile, pharmaceutical, chemical, construction, and food processing) placed under the manufacturing sector. Almost all companies (99.49%) are private, and all sample firms are large enterprises with over 100 employees.

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Table 2.3: Descriptive Statistics of the Sample

Sample (firms =196, individuals = 397)		
Individual Profile		
Variables		%
Sex		
Male	271	68.26
Female	126	31.74
Age		
< 25 years	36	9.18
25-34 years	150	37.76
35-44 years	148	37.24
45 years and above	63	15.82
Education		
High School	20	5.1
1st Degree	235	59.18
Masters	136	34.18
PhD	6	1.53
Discipline		
Accounting /Finance/ Commerce	101	25.51
Chemistry	47	11.73
Environmental Science	57	14.29
Economics	47	11.73
Engineering	49	12.24
Agriculture	57	14.29
Others	40	10.2
Industry		
Agriculture	8	4.08
Waste	37	18.88
Energy	30	15.31
Transport	10	5.1
Manufacturing	111	56.63
Ownership Structure		
Privately Owned	195	99.49
State-Owned	1	0.41
Company Size		
Small (1-30 employees)	0	0.00
Medium (31 to 100 employees)	0	0.00
Large (Over 100 employees)	196	100

Note. Table 2.3 presents the demographic profile showing the sex, age range, academic qualification, discipline studied and the sector of operation of respondents.
Source: Author's own construct (2025)

2.4.2 Reliability and Validity

Reliability and convergent validity are measured with composite reliability (CR), Cronbach's alpha (α), and average variance extracted (AVE) of latent variables, as well as the factor loadings, standard deviation, and mean of each manifest variable (Deb, Rahman, & Rahman, 2023). CR, AVE, and α

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are conducive to determining the reliability and convergent validity of reflective models. With regards to the benchmark metrics, a value between 0.70 to 0.90 is "satisfactory to good" for CR and α. In addition, an AVE of 0.50 or higher is acceptable, and a factor loading exceeding 0.70 is recommended (Hair, Risher, Sarstedt, & Ringle, 2019).

The results indicate that the factor loading of all items measuring EP, GHRM, PEMA, and MEMA (except for M1) is greater than 0.70. Also, GHRM, EP, MEMA, and PEMA have CR and α > 0.70 but below 0.95, and AVE > 0.50, thereby supporting their convergent validity and reliability.

Table 2.4: Reliability and Convergent Validity Test

Statements	Code	Mean	SD	FL	P values
Environmental Performance	EP (CR = 0.904, α = 0.858, AVE = 0.702)				
My company has achieved important environment-related certifications	EP1	5.368	1.648	0.762	0.000
My company has regularly achieved targets imposed on energy conservation, recycling or waste reduction	EP2	5.062	1.504	0.877	0.000
Due to its environmentally friendly practices, my company has saved a significant amount of money in the past (not including the achievements in terms of energy conservation, recycling, or waste reduction)	EP3	5.01	1.552	0.874	0.000
On average, the overall environmental performance of my company has improved in the past five years	EP4	5.385	1.302	0.833	0.000
Green Human Resource Management	GHRM (CR = 0.929, α = 0.912, AVE = 0.621)				
Environmentally conscious candidates are more valued by my firm	GHRM1	5.058	1.539	0.749	0.000
My firm can attract employees through environmental promises	GHRM2	4.789	1.436	0.73	0.000
My firm carries out environmental protection training for employees	GHRM3	5.262	1.535	0.801	0.000
My firm provides environmental training for management	GHRM4	5.216	1.547	0.813	0.000
Environmental responsibilities are included in the job description in my firm	GHRM5	5.031	1.518	0.788	0.000
My firm values staff participation in environmental issues	GHRM6	5.09	1.59	0.841	0.000
My firm selects employees based on environmental criteria when hiring	GHRM7	4.565	1.587	0.724	0.000
One of my firm's goals is green performance management and compensation	GHRM8	4.907	1.73	0.848	0.000
Monetary EMA	MEMA (CR = 0.929, α = 0.910, AVE = 0.651)				
My firm estimates environment-related contingent liabilities (e.g., EPA fines)	MEMA2	5.115	1.508	0.701	0.000
My firm classifies environment-related costs	MEMA3	5.036	1.576	0.848	0.000
My firm allocates environment-related costs to production or service processes	MEMA4	5.088	1.567	0.858	0.000
My firm allocates environment-related costs to products or services	MEMA5	5.068	1.532	0.804	0.000
My firm introduces or improves environment-related cost management	MEMA6	5.1	1.466	0.842	0.000
My firm creates and uses environment-related cost accounts	MEMA7	4.725	1.553	0.805	0.000

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Statements	Code	Mean	SD	FL	P values
My firm develops and uses environment-related key performance indicators	MEMA8	5.093	1.569	0.769	0.000
Physical EMA	PEMA: CR = 0.919, α = 0.858, AVE = 0.740				
My firm carries out product/service life cycle cost assessments	PEMA1	4.67	1.756	0.88	0.000
My firm does product inventory analyses (i.e., the specification of the types and quantities of materials and energy required and the amount of residues released to the environment)	PEMA2	5.097	1.655	0.812	0.000
My firm does product/service impact analyses (i.e., assessment of the environmental effect of products or services)	PEMA3	5.224	1.492	0.923	0.000
My firm does product/service improvement analysis (i.e. identification of opportunities for reduction of environmental impact)	PEMA4	5.436	1.532	0.809	0.000

Note. Table 2.4 presents the results of *the measurement model which assesses the reliability and convergent validity of the constructs.* MEMA is monetary environmental management accounting assessed with 7 indicators after the deletion of *MEMA1 because its factor loading is 0.381 < 0.5.* PEMA is physical environmental management accounting assessed with 4 indicators and GHRM indicates green human resource management measured using 8 manifest variables. EP stands for environmental performance measured with 4 indicators. *AVE= Average variance extracted, FL= factor loading and* ***CR*** *= Composite Reliability.*
Source: Author's own construct (2025)

Discriminant validity is the measure of how empirically distinct a construct is from other constructs in the model. In assessing discriminant validity, Fornell and Larcker (1981) posit that the square root of AVE of each construct should be higher than the "inter-construct correlation of that same construct and all other reflectively measured constructs in the structural model". Subsequently, Henseler et al. (2015) suggest the heterotrait-monotrait (HTMT) ratio of correlations as an improved metric to measure discriminant validity. A threshold of 0.90 or lower is proposed for conceptually similar constructs (Henseler, Ringle, & Sarstedt, 2015).

In this paper, discriminant validity was measured using the HTMT ratio of correlations, and Table 3.5 indicates that the HTMT values are all below 0.90 and therefore affirm discriminant validity.

Table 3.5: Discriminant Validity

	EP	GHRM	MEMA
GHRM	0.894		
MEMA	0.810	0.768	
PEMA	0.840	0.770	0.844

Note. Table 3.5 presents the results of the discriminant validity assessment using HTMT. **MEMA** is monetary environmental management accounting assessed with 8 indicators, **PEMA** is physical environmental management accounting assessed with 4 indicators and **GHRM** indicates green human resource management, which is measured using 8 manifest variables. **EP** stands for environmental performance measured with 4 indicators.

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Source: Author's own construct (2025)

2.4.3 Model Performance and goodness of fit

Researchers (Deb, Rahman, & Rahman, 2023; Ong, Kasbun, Abdul Rahman, Meero, & Teh, 2022; Rehman, Elrehail, Poulin, Shamout, & Alzoubi, 2023) have assessed goodness of fit and PLS-SEM performance using R-square (R^2), f-square (f^2), Q-square (Q^2), Normed fit index (NFI), and the Standardised Root Mean Square Residual (SRMR). A threshold of 0.08 or below is appropriate for SRMR, and a value of 0.80 or higher is good for NFI (Hair, Risher, Sarstedt, & Ringle, 2019; Henseler, Hubona, & Ray, 2016). Furthermore, whereas f^2 values higher than 0.02, 0.15 and 0.35 are deemed to be small, medium and large f^2 effect sizes, respectively, R^2 values of 0.75, 0.50 and 0.25 are considered substantial, moderate and weak (Hair, Risher, Sarstedt, & Ringle, 2019; Henseler, Hubona, & Ray, 2016). Finally, as a rule of thumb, Q^2 values higher than 0, 0.25 and 0.50 indicate "small, medium, and large predictive relevance of the PLS-path model (Hair, Risher, Sarstedt, & Ringle, 2019).

The R^2 values of the path GHRM to MEMA and GHRM to PEMA are 0.471 and whilst the R^2 value of all paths to EP is 0.715. This implies that the model possesses a moderate to substantial in-sample explanatory power. In other words, at least 43.8% of the variation in PEMA (47.1% for MEMA) can be explained by GHRM, whilst at least 71.5% of the variation in EP can be explained by MEMA, PEMA and GHRM.

Besides, the model has a small to large f^2 effect size because the lowest value of f^2 is 0.038, whilst the highest value is 0.889. This statistic signifies that the removal of GHRM (as an exogenous construct) has a large effect on the R^2 value of MEMA and PEMA, whilst the removal of either MEMA, PEMA, or GHRM has a small to medium effect size on the R^2 of EP. Furthermore, the model's Q^2 values of 0.461 for MEMA, 0.425 for PEMA and 0.616 for EP are indications of its large predictive accuracy. Additionally, the SRMR of 0.054 being less than 0.08 is a confirmation of the out-of-sample predictive power of the model. The goodness of fit of this model is equally confirmed

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by an NFI value of 0.853 > 0.80. However, as advised by Hair et al. (2019), model fit indices for PLS-SEM are still being developed, so they ought to be considered with extreme caution. The results are displayed in Table 2.6 below.

Table 2.6: Model's performance and goodness of Fit

	R^2	f^2	Q^2	SRMR	NFI
GHRM -> MEMA	0.471	0.889	0.461	0.054	0.853
GHRM -> PEMA	0.438	0.780	0.425		
MEMA -> EP	0.715	0.038	0.616		
PEMA -> EP		0.107			
GHRM -> EP		0.400			

Note. Table 2.6 presents the result of the model's performance. It shows the extent to which variations in dependent variables PEMA, MEMA and EP are explained by independent variables **MEMA**, **PEMA** and **GRHM**. **MEMA** is monetary environmental management accounting assessed with 8 indicators, **PEMA** is physical environmental management accounting assessed with 4 indicators and **GHRM** indicates green human resource management, which is measured using 8 manifest variables. **EP** stands for environmental performance measured with 4 indicators.
Source: Author's own construct (2025)

2.4.4 Hypothesis testing

Table 2.7 indicates that GHRM positively and significantly affects MEMA (β = 0.686, p = 0.000) thereby supporting H1a. To expatiate on this, an increase in GHRM by a unit would lead to an improvement in MEMA by 0.686. Likewise, GHRM enhances PEMA (β = 0.662, p = 0.000) and confirms H1b. Aside from that, MEMA is significantly and positively (β = 0.172, p = 0.029) related to EP. PEMA, just like MEMA, is significantly and positively (β = 0.28, p = 0.001) associated with EP. These results confirm hypotheses H2a and H2b. With regards to H3, the results indicate that GHRM has a significant and positive effect (β = 0.487, p = 0.000) on EP.

Hypothesis 4 assesses the mediating role of EMA (composed of MEMA and PEMA) on the relationship between GHRM and EP. Using a bootstrapping procedure with 10,000 subsamples and at a 95% confidence interval, the result reveals that the indirect effect of GHRM on EP via PEMA was significant (β = 0.186, p = 0.003). Similarly, the indirect effect of GHRM on EP through MEMA was significant (β = 0.118, p = 0.029). Consequently, H4a and H4b are supported, and the implication is that EMA mediates between the influence of GHRM on EP. Following Hair, et al. (2017a) this

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mediation is classified as complementary partial mediation because (1) the indirect effects of GHRM on EP through MEMA (and through PEMA) are significant, (2) the direct effect of GHRM on EP is significant, and (3) the product of the direct effect and the indirect effect is positive. Practically, this signifies that when GHRM and EMA are practised cohesively, the influence of GHRM on EP as translated through EMA becomes greater than the direct impact of GHRM on EP.

Table 2.7: Direct and Indirect Effects

Effects	Path in SEM	Coeff. (β)	P values	Decision
Direct effects	GHRM -> MEMA	0.686	0.000	H1a supported
	GHRM -> PEMA	0.662	0.000	H1b supported
	MEMA -> EP	0.172	0.029	H2a supported
	PEMA -> EP	0.280	0.001	H2b supported
	GHRM -> EP	0.487	0.000	H3 supported
Indirect effects	GHRM -> PEMA -> EP	0.186	0.003	H4a supported
	GHRM -> MEMA -> EP	0.118	0.029	H4b supported
Total effects	GHRM -> EP	0.791	0.000	

Note. Table 2.7 presents the results of the hypothesis testing. **MEMA** is monetary environmental management accounting assessed with 8 indicators, **PEMA** is physical environmental management accounting assessed with 4 indicators, and **GHRM** indicates green human resource management, which is measured using 8 manifest variables. **EP** stands for environmental performance measured with 4 indicators.
Source: Author's own construct (2025)

2.4.5 Differential Impact of MEMA and PEMA

Table 2.8 compares the effects of GHRM on MEMA and PEMA and the effects of MEMA and PEMA on EP to ascertain the factor with the strongest influence. Comparing the direct impact of GHRM on MEMA ($\beta = 0.686$, $p < 0.001$) against the impact of GHRM on PEMA ($\beta = 0.662$, $p < 0.001$), one observes that GHRM's effect on MEMA is slightly stronger than the effect on PEMA. Similarly, although the effect sizes of GHRM on MEMA **($f^2 = 0.889$)** and PEMA **($f^2 = 0.780$)** are both large effect sizes ($f^2 > 0.35$), GHRM's impact on MEMA is narrowly stronger. Considering the predictive relevance (Q^2), both MEMA **($Q^2 = 0.461$)** and PEMA **($Q^2 = 0.425$)** have strong predictive relevance ($Q^2 > 0.35$), but MEMA's predictive relevance is a bit higher than that of PEMA. These statistics imply that the GHRM practices are not only marginally more effective in shaping MEMA than PEMA, but they also explain more variance in MEMA than in PEMA.

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Besides, the direct impact of PEMA on EP (β = 0.280, p = 0.001) is stronger than the impact of MEMA on EP (β = 0.172, p = 0.029). In addition, PEMA (f^2 = 0.107) has a small but meaningful effect (f^2 > 0.02), while the effect size of MEMA (f^2 = 0.038) is negligible (f^2 > 0.02). This signifies that PEMA is a more critical environmental driver than MEMA and contributes more to explaining EP than MEMA.

Furthermore, the indirect effect of GHRM on EP via PEMA (β = 0.186, p = 0.003) is stronger by 57.63% than the indirect effect of GHRM on EP via MEMA (β = 0.118, p = 0.029), indicating that PEMA plays a more significant mediating role between GHRM and EP than MEMA. Finally, the total effect of GHRM on EP (total effect = 0.791, p < 0.001), given the direct effect of 0.487, allows for the conclusion that PEMA contributes more to the total effect (23.5%) than MEMA (14.9%). Collectively, it is appropriate to assert that in deploying GHRM strategies to improve EP via EMA, organisations should prioritise PEMA over MEMA.

Table 2.8: Differential Effects

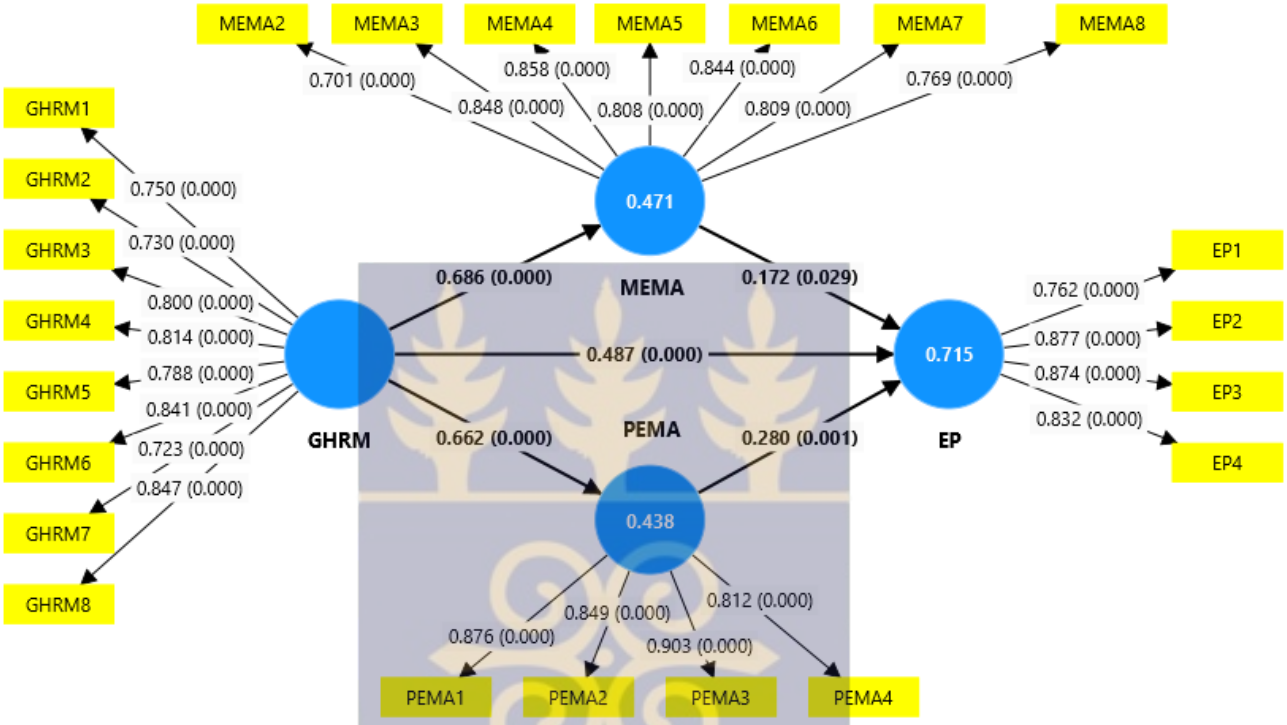
Parameter	MEMA	PEMA	Remark
Direct Effect (GHRM → MEMA/PEMA)	β = 0.686 (stronger)	β = 0.662	GHRM influences MEMA slightly more.
Direct Effect (MEMA/PEMA → EP)	β = 0.172 (weaker)	β = 0.280 (stronger)	PEMA impacts EP more.
Effect Size (f^2, MEMA/PEMA → EP)	0.038 (negligible)	0.107 (small but meaningful)	PEMA explains more EP variance.
Indirect Effect	β = 0.118 (weaker mediation)	β = 0.186 (stronger mediation)	PEMA is a better mediator.
Mediation Contribution	14.9% of the total effect	23.5% of the total effect	PEMA mediates more of GHRM's overall impact on EP.
Predictive Relevance (Q^2)	0.461 (strong)	0.425 (strong)	Comparable, but MEMA is slightly better.

Note. Table 2.8 compares the differential effects of GHRM on MEMA and PEMA, and those of **MEMA and PEMA on EP. MEMA** is monetary environmental management accounting, **PEMA** is physical environmental management accounting, and **GHRM** indicates green human resource management. **EP** stands for environmental performance measured with 4 indicators.
Source: Author's own construct (2025)

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A graphical representation of the results, as an output of SmartPLS version 4, is displayed in Figure 2.2.

Figure 2.2: Structural Equation Model of the Mediation of EMA



Note. Author's own work (2025)

2.4.6 Discussion of results

Following NRBV (Hart S. L., 1995; Hart & Dowell, 2011) and Stakeholder Theory (Freeman, 1984; Horisch, Schaltegger, & Freeman, 2020), this study hypothesises that GHRM will positively impact MEMA and PEMA. The results confirm this hypothesis by indicating that GHRM positively and significantly impacts MEMA and PEMA. There is no such study, to the best of our knowledge, that has examined the effects of GHRM on EMA. The closest in this regard is the work of Liu & Zhang (2022), which assesses the impact of EMA on GHRM and found a positive effect of EMA on GHRM. The contribution of this chapter is not just about evaluating the impact of GHRM on EMA, but the differential effect of GHRM on the components of EMA (i.e. MEMA and PEMA). The results of

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this study indicate that GHRM's impact on MEMA is slightly stronger than its effect on PEMA, and GHRM practices also explain more variance in MEMA than in PEMA.

Similarly, in confirming the hypothesis H3 derived from the NRBV (Hart S. L., 1995; Hart & Dowell, 2011) and Stakeholder Theory (Freeman, 1984; Horisch, Schaltegger, & Freeman, 2020), the result indicates that GHRM significantly and positively impacts EP. This finding reinforces the robustness of the relationship between GHRM and EP in a different context, given that the same findings were made by Aftab, Abid, & Cucari (2022) in Pakistan, Nisar et al. (2021) in Malaysia and Asfahani (2023) in Saudi Arabia.

Moreover, the study aligns with NRBV (Hart S. L., 1995; Hart & Dowell, 2011) and Stakeholder Theory (Freeman, 1984; Horisch, Schaltegger, & Freeman, 2020) in affirming that EMA significantly and positively impacts EP. Empirical studies providing additional evidence in this regard include Deb, Rahman, & Rahman (2023) and Le, Nguyen, & Phan (2019) whose results indicate that EMA positively enhances EP and financial performance. Unlike previous works, this research provides new insight by demonstrating that PEMA impacts EP more than MEMA does, and it explains more of the variation in EP than MEMA.

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Finally, the result conforms with NRBV (Hart S. L., 1995; Hart & Dowell, 2011) and Stakeholder Theory (Freeman, 1984; Horisch, Schaltegger, & Freeman, 2020) and affirms that MEMA and PEMA are mechanisms through which GHRM influences EP. Both PEMA and MEMA complimentary mediate the relationship between GHRM and EP. However, PEMA is a better mediator, adding more to GHRM's overall impact on EP than MEMA. This assessment fills the existing research vacuum by elucidating how EMA complementary mediates a functional strategy through physical and monetary information and practices, leading to enhanced EP.

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2.5 Conclusion

This chapter examined the mediating role of EMA in the relationship between GHRM on EP in high-polluting industries of Ghana. It highlights the differential impacts of PEMA and MEMA (as components of EMA) in the association between GHRM and EP. Primary data was collected through a survey using adopted scales from Wang (2019), Liu & Zhang (2022) and Ferreira et al. (2010). Senior managers of manufacturing firms, transport companies, power generators, waste management firms and agriculture companies in six cities of Ghana responded to the questionnaires. In total, 397 valid individual-level responses were received, and this permitted the computation of 196 firm-level responses in line with the suggestion of Miao et al. (2012).

Knowing that the use of surveys to collect data is prone to common method bias and nonresponse bias, procedural control and statistical controls were deployed to deal with common method bias, while T-tests were conducted to assess non-response bias. Following the recommendation of Kock, Berbekova, & Assaf (2021) procedural controls of guaranteeing the anonymity of respondents, piloting of the survey instrument and psychological separation were utilised. In addition, a statistical test involving VIFs of latent variables was computed. The results being lower than 3.3 showed that common method bias was not a concern. Furthermore, nonresponse bias was assessed with the help of T-tests using SPSS software. The result of a comparison of the means of 50 firm-level early respondents to 50 firm-level late respondents indicated that there is no difference in the means. Consequently, nonresponse bias was also not a problem affecting the data collected.

Having satisfied the conditions relating to the two biases above, SmartPLS version 4 enabled the computation of a PLS-SEM involving four constructs (GHRM, MEMA, PEMA and EP) and 23 indicators. The first stage of the analysis dealt with the measurement module, where the reliability, validity and goodness of fit of the module were confirmed. Precisely, the factor loading of the indicators, composite reliability, and Cronbach's alpha of the constructs were above 0.70 but below 0.95. Also, the Average Variance Extracted of the latent variables was above 0.50, thereby supporting their convergent validity and reliability (Hair, Risher, Sarstedt, & Ringle, 2019). Finally, discriminant

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validity was confirmed with the HTMT ratio of correlations, with all the results below 0.90 (Henseler, Ringle, & Sarstedt, 2015).

The second stage of the PLS-SEM analysis involved testing the five hypotheses. The results indicate that GHRM significantly improves MEMA and PEMA on the one hand and equally enhances EP on the other hand. These findings support the research hypothesis. Similar results were obtained by other scholars (Aftab, Abid, & Cucari, 2022; Nisar, et al., 2021). More importantly, the study confirms the assertions in NRBV that strategic capacities (i.e. pollution prevention, product stewardship and sustainable development) have differential effects on sustainability performance. It shows that GHRM more effectively shapes MEMA than PEMA and explains more variance in MEMA than in PEMA. Moreover, MEMA and PEMA positively and significantly influence EP in a finding which is akin to earlier studies (Deb, Rahman, & Rahman, 2023; Le, Nguyen, & Phan, 2019). More importantly, concerning their direct differential impacts, PEMA is a more critical environmental driver than MEMA and contributes more to improving EP than MEMA.

By assessing the differential effects of MEMA and PEMA in the mediation of EMA in the relationship between GHRM and EP, this chapter contributes to the literature by enhancing the understanding of the mechanism by which GHRM impacts EP. It illustrates that HR of a firm, equipped with green skills, can optimise EMA as a strategic tool to improve EP. However, PEMA contributes more to the influence of GHRM on EP than MEMA. In addition, by establishing that EMA mediates the relationship between GHRM and EP, the study provides empirical evidence to incentivise managers aiming at achieving better EP to practise both GHRM and EMA effectively and cohesively. This can be done by integrating the development of knowledge and skills of EMA practices in GHRM training and by establishing permanent cross-functional green teams that include both environmental management accountants and HR/operations personnel as standing members, not ad-hoc consultants.

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It further highlights the necessity to prioritise PEMA as a mechanism if one wishes to attain greater improvement in EP.

2.6 Policy Implications

The findings have significant implications for policy at the firm level and the national level. Starting with the level of the firm, it is expedient to mention that the positive and significant influence of GHRM on EP through EMA calls for organisations to reinvigorate policies linked to the promotion of GHRM. In specific terms, because PEMA contributes more to the total effect of GHRM on EP than MEMA, there should be prioritisation of PEMA in policies. For corporations, there should be emphasis on the recruitment and selection of ecologically conscious candidates. Managers should include in the terms of reference for job advertisements the requirement for previous experience with environmental projects and an appreciation of environmental ethics. This requirement should also be probed during interviews to ensure that successful candidates are committed to ecological sustainability. Thereafter, policies should encourage continuous training and development of staff in the evolving dynamics associated with sustainability. This includes training on waste reduction, efficient material usage, ecological impacts of production, and sustainability accounting standards. In addition, companies could integrate sustainability targets in staff appraisal and make it contingent on promotion. Finally, an award scheme could be instituted in firms to incentivise departments with the largest reduction in environmental footprint within a period.

It is equally evident from this study that EMA significantly enhances EP. Consequently, policies that reinforce EMA in organisations must be promoted by governments and firms. A principal driver of EMA in firms is the obligation to abide by statutory regulations that enhance environmental sustainability (Nartey, 2018; Burritt, Schaltegger, & Zvezdov, 2011). Therefore, governments must continue to improve and enforce regulations in line with new developments affecting the ecology. In Ghana, for instance, an assessment of the effectiveness of laws governing pollution and the protection of fauna and flora needs to be conducted to plug loopholes. When this is achieved, companies seeking

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to remain in operational existence will have no option but to comply, and EMA, being a great strategic tool in ensuring compliance, will eventually thrive.

Additionally, the government can stimulate investment in environmental technologies, such as the information system requirements for effective EMA practice. Körner, Michaelis, Spazierer, & Strüker (2023) suggested that data input, data processing and output systems are necessary for EMA implementation. Therefore, the government could grant tax incentives or subsidies to firms wishing to invest in such technologies. This would facilitate the acquisition of state-of-the-art technologies needed for advancing EMA and reducing environmental degradation.

2.7 Limitations and future recommendations

The limitations of this study are partly embedded in the use of PLS-SEM for the analysis. The model fit indices have not been well tested and therefore, as preconised by Hair, Risher, Sarstedt, & Ringle (2019), researchers should be very cautious when considering the applicability of these measures to PLS-SEM. Consequently, the goodness of fit indices computed in this work (R^2, f^2 and Q^2) should be considered tentative. This study dealt with the limitation by considering alternative goodness of fit metrics like the Standardised Root Mean Square Residual (SRMR), which detects model misspecification, measuring the discrepancy between observed correlations and model-implied correlations (Hair J. F., Hult, Ringle, & Sarstedt, 2022). SRMR has, however, been criticised as being less strict than covariance-based structural equation models (Rönkkö, 2013). This study could not use covariance-based SEM because the data is not normally distributed. Consequently, future studies should use covariance-based structural equation models because of their well-tested and universally accepted model fit indices.

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CHAPTER THREE

Repositioning Environmental Management Accounting as a Strategic Capability: The Case of the Manufacturing Sector in Ghana

Abstract

Growing global concerns over environmental degradation have intensified calls for businesses to adopt sustainable practices. In Ghana, where manufacturing firms significantly contribute to pollution, Environmental Management Accounting (EMA) has emerged as a pivotal reporting tool, but it usefulness as a strategic capability within the Natural Resource-Based View (NRBV) remains doubtful. This study examines whether Environmental Management Accounting (EMA) functions as an environmental capability within the Natural-Resource-Based View (NRBV). It investigates whether EMA's two components—physical (PEMA) and monetary (MEMA) — exert differential effects within the NRBV's proposed cycle linking capabilities to competitive advantage and environmental performance.

Survey data were collected from 231 senior managers across 85 manufacturing firms in Ghana and analysed using Partial Least Squares Structural Equation Modelling. The findings reveal that PEMA significantly enhances both competitive advantage and environmental performance, confirming its strategic role. In contrast, MEMA improves only environmental performance, suggesting a more operational or compliance-focused function. Crucially, competitive advantage does not mediate the EMA–EP relationship; instead, it emerges as a co-occurring outcome of PEMA.

The study contributes to the literature by providing a novel empirical test of the NRBV through EMA, challenging the assumed virtuous cycle from capabilities to competitive advantage to environmental performance. For policymakers, the findings highlight the importance of promoting PEMA adoption

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through incentives. For managers, the results underscore the strategic value of investing in physical environmental accounting systems to advance ecological and competitive objectives simultaneously, rather than relying solely on cost-focused MEMA frameworks

3.1 Introduction

Growing global concerns over environmental degradation have intensified calls for businesses to adopt sustainable practices and mitigate their ecological footprints (UNFCCC, 2016). In developing economies such as Ghana, where industrial expansion and manufacturing activities significantly contribute to pollution and resource depletion, the imperative for corporate environmental stewardship is particularly acute (GSS/EPA, 2020). This imperative is driven by mounting pressure from a broad range of stakeholders, including regulators, communities, investors, and consumers, who demand greater ecological accountability (Freeman, 1984; Horisch, et al., 2020). In response, Environmental Management Accounting (EMA) has emerged as a critical management tool, designed to meet these stakeholder demands by providing the information necessary to align ecological responsibility with economic objectives. Zandi & Lee, (2019) posit that EMA is the administration of financial and non-financial evidence relating to the environmental impact of a firm's operation to ensure that the firm is ecologically responsible. It encompasses accounting systems and practices that enhance environmental management and increase economic performance (Prajogo, Murwaningsari, & Mayangsari, 2023). These systems are used for measurement (e.g. Material Flow Cost Accounting, Carbon Management Accounting and Eco-investment), auditing, and controlling (e.g. sustainability balanced scorecard) (Qian, Hörisch, & Schaltegger, 2018). EMA is subdivided into monetary environmental management accounting (MEMA) and physical environmental management accounting (PEMA) (Liu & Zhang, 2022; Qian, Burritt, & Monroe, 2010). MEMA relates to the environmental impact estimated in terms of money, whilst PEMA pertains to a firm's environmental impacts that are quantified in physical units (Liu & Zhang, 2022).

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While Stakeholder Theory explains the pressure to adopt sustainable practices like EMA, the Natural Resource-Based View (NRBV) explains the internal strategic potential of such practices (Hart, 1995; Hart & Dowell, 2011). The NRBV posits that firms can build sustainable competitive advantages through unique environmental capabilities. In the context of environmental sustainability, COMP refers to a unique capability and strategy that enables a firm to outperform its rivals while achieving environmental, social and economic goals (Hart, 1995). NRBV implies a strategic pathway where capabilities fostered by EMA, such as pollution prevention, product stewardship and sustainable development, first confer a competitive advantage (COMP). This advantage, in turn, provides the resources and market legitimacy to achieve superior environmental performance (EP).

Theoretically, the significance of EMA is increasingly framed through the lens of the NRBV. Scholars posit that EMA can constitute a valuable, firm-specific capability that fosters a sustainable competitive advantage (COMP), aligning with NRBV. However, a critical oversight persists in this literature. Prevailing empirical research, while demonstrating EMA's positive influence on COMP (Rahman, et al., 2021; Dunk, 2007), treats EMA as a single construct without distinguishing between its two components. EMA comprises two distinct components: Monetary EMA (MEMA), which tracks environmental costs, and Physical EMA (PEMA), which measures material and energy flows (Liu & Zhang, 2022). It remains unexplored whether these components differentially contribute to COMP. For managers, this distinction is relevant to deal with the pressing resource allocation dilemma. If one component is the true driver of COMP, it merits strategic investment as a capability. If not, it may be relegated to a mere operational cost for compliance.

Furthermore, the NRBV proposes a specific strategic sequence: environmental capabilities should not only create competitive advantage but also use that advantage to engender further improvement in EP, implying a mediated pathway (Hart & Dowell, 2011). Thus, for EMA to be a capability, it should lead to COMP and EP, with the possibility of COMP causing additional improvement in EP. While separate research streams confirm that EMA enhances both COMP (Rahman, et al., 2021;

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Dunk, 2007) and EP (Ong, et al., 2022; Deb, 2023; Abdul Rasit, et al., 2023; Hasan, et al., 2024), it remains unknown whether these outcomes are causally linked or merely co-occurring. Testing the integrated pathway (EMA→COMP→EP) provides empirical evidence to establish whether EMA can be repositioned from a mere information tool to a strategic capability (Zatini, et al., 2025) in line with Hart's (1995) NRBV. For practitioners, this evidence is required for justifying strategic investments in EMA systems and repositioning them from compliance-focused accounting exercises to integral components of sustainable competitive strategy.

To address these dual gaps, this study investigates the manufacturing sector in Ghana with two primary objectives: to examine the differential effects of MEMA and PEMA on competitive advantage and environmental performance, and to test whether competitive advantage mediates the relationship between each EMA component and environmental performance.

Utilising survey data from 231 senior managers across 85 firms and analysing it with Partial Least Squares Structural Equation Modelling (PLS-SEM), the findings reveal a clear divergence: only PEMA significantly enhances competitive advantage, while MEMA does not. Although both components directly improve environmental performance, COMP does not mediate this relationship. This indicates that the components of EMA behave unequally and that superior environmental performance can be achieved independently of COMP. This outcome conforms with Ma's (2000) contention that superior performance can be attained without COMP, extending this debate into the domain of sustainable development. For practitioners, the implications are that managers should invest in PEMA for competitive and environmental benefits, but treat MEMA primarily as a compliance and cost-control tool. Crucially, they must plan for environmental and competitive goals separately, as the former does not automatically flow from the latter. This study thereby provides empirically grounded clarity for theory refinement and strategic decision-making in sustainable business practice.

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The study quantitatively analyses data collected from manufacturing firms in six towns of Ghana through a survey. Manufacturing firms were sampled because of their environmentally sensitive nature, characterised by high energy consumption, material usage, and waste generation. Besides, manufacturing firms face intense competition, making the sector an ideal setting for research on competitive advantage.

Responses from 231 individuals were converted to 85 firm-level responses following Miao, Cai, & Xu (2012). Preliminary assessment indicates the absence of common method bias and nonresponse bias. Partial Least Squares Structural Equation Modelling (PLS-SEM) facilitated the testing of hypotheses.

The results surprisingly indicate that of the two components of EMA, only PEMA drives both COMP and EP, qualifying it as an environmental capability in line with NRBV. MEMA drives only EP but has no impact on COMP. The relationship between EMA and EP is not mediated by COMP. The research, therefore, illustrates the unequal behaviour of EMA components. It further points out that superior environmental performance can be achieved without COMP. This aligns with Ma's (2000) critique of Porter's (1980) assertion that competitive advantage drives financial performance. Ma (2000) contends that superior performance can be attained without a competitive advantage. The findings extend this debate beyond the domain of financial or market performance into sustainable development. The findings highlight the need for managers to plan and budget for competitiveness and environmental performance separately and not to expect that competitive advantage automatically drives environmental performance. Essentially, managers should invest in PEMA for competitive and environmental benefits, but invest in MEMA only for compliance and cost control.

The study is organised as follows: Section 3.2 reviews theoretical and empirical literature on the subject, Section 3.3 considers the research methods and Section 3.4 deals with the empirical results. Finally, the study concludes and proffers policy implications.

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3.2 Literature Review

This section defines the variables of the study and relies on NRBV to offer a theoretical underpinning for the hypothesis that EMA influences EP through COMP. Empirical evidence is equally provided to support the hypothesis. The integration of COMP into the EMA–EP relationship provides insight into the mechanism by which EMA affects EP.

3.2.1 Environmental Management Accounting

EMA involves 'the identification, collection, analysis and use of a broad scope of information for internal decision-making' (Qian, Burritt, & Monroe, 2010) about the protection of the environment. It encompasses the utilisation of both physical environmental management accounting (PEMA) and monetary environmental management accounting (MEMA) (Liu & Zhang, 2022; Qian, Burritt, & Monroe, 2010). Both PEMA and MEMA provide relevant information to minimise the impact of a firm's activity on the ecology (Zandi & Lee, 2019). MEMA is concerned with the cost of inputs and outputs used to reduce the environmental impact of a firm's activities, whilst PEMA deals with the tangible resources utilised in the production process and the waste generated (Prasetya, 2021). EMA entails accounting for both the cost of input and the material inputs (such as water, energy and other resources) and physical outputs, including waste and emissions (Liu & Zhang, 2022; Qian, Burritt, & Monroe, 2010). EMA involves accounting practices and accounting systems that facilitate environmental management and ameliorate economic performance (Prajogo, Murwaningsari, & Mayangsari, 2023). EMA is a resource of immense value for competitive advantage as it provides information (Schaltegger & Csutora, 2012) for risk management (Ong, Kasbun, Abdul Rahman, Meero, & Teh, 2022), investment or divestment (Bui & Fowler, 2019; Krueger, Sautner, & Starks, 2020), project financing (IFC, 2012) and green marketing (Leonidou L. C., Leonidou, Fotiadis, & Zeriti, 2013; Fraj, Martínez, & Matute, 2011).

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3.2.2 Competitive advantage

Competitive advantage is a superior position that a firm possesses over its rivals in a marketplace due to its ability to create unparalleled positive values (Wang, 2019). It is influenced by demand, industry, a firm's strategy, structure, and rivalry (Rose, Abdullah, & Ismad, 2010). Porter (1980) recognises two basic types of competitive advantage: cost leadership and differentiation. Cost leadership competitive advantage is achieved when a firm creates a value that surpasses the cost of creating it, leading to the offering of lower prices than those of its competitors for the same benefits to customers. Differentiation as a competitive advantage is achieved when a firm provides unique benefits to customers exceeding those of its rivals, which enables the firm to offset the higher prices it charges. Porter's definition, according to Ma (2000) equates competitive advantage to performance, and therefore, Ma (2000) proposes a different definition. According to Ma (2000), competitive advantage is a 'differential between two competitors on any conceivable dimension that allows one to better create customer value than the other'. This implies that a firm can achieve a competitive advantage without superior performance.

3.2.3 Environmental performance

Environmental performance is the conduct of an organisation regarding the environment. It relates to the way the organisation uses resources to reduce pollution (Singh, Chen, Giudice, & El-Kassar, 2019). Wang (2019) specifies that corporate environmental performance refers to the interaction between the environment and a business, such that there is minimal adverse impact of the business's operation on the ecology. To improve environmental performance firms engage in the use of biodegradable materials in products, the consumption of less energy, the reduction of waste, and the minimisation of environmentally harmful products (Singh, Chen, Giudice, & El-Kassar, 2019; Ong, Kasbun, Abdul Rahman, Meero, & Teh, 2022).

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3.2.4 Natural resource-based view

Natural Resource-Based View (NRBV) provides a theoretical underpinning for the mediation of COMP in the relationship between EMA and EP. According to NRBV, a firm can achieve COMP and EP through capabilities such as pollution prevention, product stewardship (Hart S. L., 1995), and clean technology (Hart & Dowell, 2011). These capabilities have a differential impact on COMP and EP because they are heterogeneous, hierarchical and dynamic (Barney J. , 1991; Hart S. L., 1995; Teece, Pisano, & Shuen, 1997). Heterogeneous capabilities are the different skills, processes and knowledge developed over time, which differ in maturity and integration, and cause varied impacts on COMP and EP (Barney J. , 1991). Capabilities are dynamic because they evolve and exert unequal impacts at different stages of their evolution (Teece, Pisano, & Shuen, 1997). Capabilities are hierarchical, with basic ones providing an anchor for building advanced capabilities (Barney J. , 1991; Hart S. L., 1995) leading to differential impacts.

Pollution prevention capabilities focus on minimising waste and emissions at the source through the efficient utilisation of inputs. This saves the cost of investing in pollution prevention technologies, lowers the cost of raw materials and waste disposal, and avoids the cost of non-compliance with environmental regulations (Hart S. L., 1995; Hart & Dowell, 2011). Firms that significantly reduce these costs vis-à-vis those of their rivals while maintaining the same quality of service or product are likely to benefit from a cost-competitive advantage (Porter & van der Linde, 1995). Moreover, the use of less input material and the reduction in waste and emissions minimise the depletion of natural resources and enhance EP. EMA assists in measuring and monitoring the quantum and cost of these waste, emissions and resource use, allowing managers to reduce inefficiency, achieve COMP and enhance EP (Zatini, Porta, & Za, 2025; Molina-Azorin, Maria, Juan, Jorge, & Eva, 2021).

Besides, product stewardship (Hart & Dowell, 2011; Hart S. L., 1995) relates to minimising the adverse environmental impacts of products throughout their lifecycle. EMA tools, such as Material Flow Cost Accounting, Supply Chain Accounting, Lifecycle Costing, Supplier Audits, etc

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(Schaltegger & Burritt, 2017), provide feedback on the product and processes that require improvement, leading to an investment decision to design greener products or services. Once an eco-design is achieved, firms can rely on product or service differentiation as a source of competitive advantage. This enables them to focus on environmentally conscious clients and charge a premium price (Hart & Dowell, 2011; Hart S. L., 1995) while attaining higher EP.

Finally, clean technology, stemming from Hart's (1995) proposition of sustainable development, "deals with the way that firms build new competencies and position themselves for competitive advantage as their industries evolve" (Hart & Dowell, 2011). It reduces material and energy consumption, enabling humans to meet their needs without straining the resources of the planet. It minimises pollution and creates first-mover advantages in emerging green markets (Hart & Dowell, 2011). EMA influences the adoption of clean technologies by providing eco-investment data to ensure efficient financing of clean technologies, resulting in a long-term improvement in EP. The possession of clean technologies by a firm is a viable avenue for the pursuit of a differentiation focus strategy targeting eco-conscious consumers, underserved segments and tech enthusiasts (Hart & Dowell, 2011; Hart S. L., 1995). Once this competitive advantage is achieved, continuous investment in clean technology ensures sustainable enhancement of EP.

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3.2.5 Environmental Management Accounting and Competitive Advantage

Based on NRBV, this study hypothesises that MEMA/PEMA significantly enhances the COMP. EMA provides valuation information towards the implementation of pollution prevention, which reduces cost through efficient use of inputs, resulting in a cost leadership competitive advantage (Porter & van der Linde, 1995; Hart & Dowell, 2011).

Besides, EMA provides valuable feedback in product stewardship, leading to the design of eco-friendly products, which serve as a basis for product differentiation, leading to COMP. Also, EMA influences the adoption of clean technologies, resulting in innovations engendering COMP.

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In addition to the above, several empirical studies support the influence of EMA on COMP. For example, Rahman, Deb, & Rahman (2021) examined the impact of EMA on cost COMP using PLS-SEM to analyse a sample of 268 responses from Bangladeshi manufacturing firms listed on the Dhaka Stock Exchange. They found that EMA has a direct positive effect on cost COMP. Additionally, Dunk (2007) assessed the effects of product quality and EMA on COMP drawing from a sample of 119 managers of manufacturing companies in Australia. The results indicate that product quality's impact on COMP is contingent on EMA. When there is high reliance on EMA, product quality positively affects COMP, but it fails to do so when there is low reliance on EMA. Based on the NRBV and empirical evidence above, it is conjectured that EMA (comprising PEMA and MEMA) is positively related to COMP.

H1a: MEMA is positively related to competitive advantage.

H1b: PEMA is positively related to competitive advantage.

3.2.6 Competitive advantage and environmental performance

NRBV further supports the hypothesis that COMP will significantly impact EP. Firms enjoying COMP are better positioned to invest in green technology and optimise resources to enhance their EP (Hart & Dowell, 2011).

Empirical studies have examined the association between COMP and financial performance, indicating that financial performance leads to COMP (Ismail, Rose, Abdullah, & Uli, 2010; Rose, Abdullah, & Ismad, 2010; Leonidou L. C., Leonidou, Fotiadis, & Zeriti, 2013; Morgan, Kaleka, & Katsikeas, 2004). However, there is limited empirical research on the impact of COMP on EP. Studies have so far focused on the influence of EP on COMP or the association of some variables with EP and COMP. For instance, in a study on environmental ethics, EP, COMP and environmental training in the United Arab Emirates, Singh, Chen, Giudice, & El-Kassar (2019) indicate that environmental

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ethics influences environmental training, EP, and COMP. Moreover, the study discloses that environmental training mediates the influence of environmental ethics on EP and COMP. However, the study did not examine the impact of COMP on EP. Lee, et al. (2013) looked at the impact of greening suppliers on EP and COMP in Malaysia. The results illustrate that greening suppliers have a significant positive relationship with EP and COMP. Furthermore, EP significantly and positively influences COMP, indicating its mediating role in the association between greening suppliers and COMP. The research considers the influence of EP on COMP but not the inverse, which is the prime concern of this work. Due to the limited research on the impact of COMP on EP, this work relies solely on the NRBV, as explained, to hypothesise as follows:

H_2: Competitive advantage is positively related to environmental performance.

3.2.7 Environmental Management Accounting and Environmental Performance

From NRBV, EMA improves pollution prevention by precisely measuring and monitoring waste, emissions, and resource use (Zatini et al., 2025; Molina-Azorin et al., 2021), enabling firms to reduce compliance costs and operational inefficiencies (Hart, 1995; Hart & Dowell, 2011). Besides, EMA tools like Material Flow Cost Accounting and Lifecycle Costing (Schaltegger & Burritt, 2017) help to identify and address gaps in material flows and supply chain ecological impacts to improve EP.

Empirical literature (Ong, Kasbun, Abdul Rahman, Meero, & Teh, 2022; Deb, 2023; Abdul Rasit, Bahari, & Alam, 2023; Hasan, Waghule, & Hasan, 2024) evinces that EMA improves EP. Firstly, Ong, et al. (2022) examined the mediating effect of EMA in the relationship between carbon risk management and EP of Malaysian firms. Using PLS-SEM to analyse a sample of 136 responses, the study concludes that EMA mediates the influence of carbon risk management on EP. This finding supports the assertion that EMA positively influences EP. Similarly, in a study of 299 Yemeni manufacturing SMEs using PLS-SEM, Hasan, Waghule, & Hasan (2024) found that EMA positively

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and directly affects EP. Also, the effect of EMA on EP is mediated by top management support and institutional pressure. In another research on EMA's role in the link between Environmental Strategy and EP, Abdul Rasit, Bahari, and Alam (2023) sampled members of the Malaysian electrical and electronic industry and the Electrical and Electronic Association. Using PLS-SEM for the analysis, the findings indicate that EMA mediates the influence of environmental strategy on EP. Finally, Deb (2023) investigated the impact of EMA on EP and the financial performance of manufacturing companies in Bangladesh. The analysis was conducted using PLS-SEM on a sample of 323 firms. The research concluded that EMA positively and significantly affects both EP and financial performance. Relying on the NRBV and these empirical findings, this study hypothesises as follows:

H3a: MEMA will positively affect environmental performance.

H3b: PEMA will positively affect environmental performance.

The association between EMA, COMP and EP is represented in a conceptual framework displayed in Figure 3.1.

3.2.8 Mediation effect of competitive advantage

In line with NRBV (Hart S. L., 1995), this study argues that EMA indirectly improves EP through COMP. EMA provides data that enables the cost leadership COMP, as waste and eco-efficiency are achieved (Hart S. L., 1995). Similarly, EMA is a useful tool in ensuring that the ecological features of a product are highlighted to entice eco-friendly consumers, leading to product differentiation COMP and better EP (Hart & Dowell, 2011). The information provided by EMA carries a different level of usefulness to stakeholders (Horisch, Schaltegger, & Freeman, 2020). Besides, EMA's two components (i.e. PEMA and MEMA) have different effects on COMP and EP because they are capabilities that are heterogeneous, dynamic, and hierarchical (Barney J. , 1991; Hart S. L., 1995; Teece, Pisano, & Shuen, 1997). Consequently, they exist at various levels of maturity and integration into the firm's operation, leading to unequal effects on COMP and EP. This hypothesis is formulated as follows:

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H4a: MEMA will positively affect EP through COMP

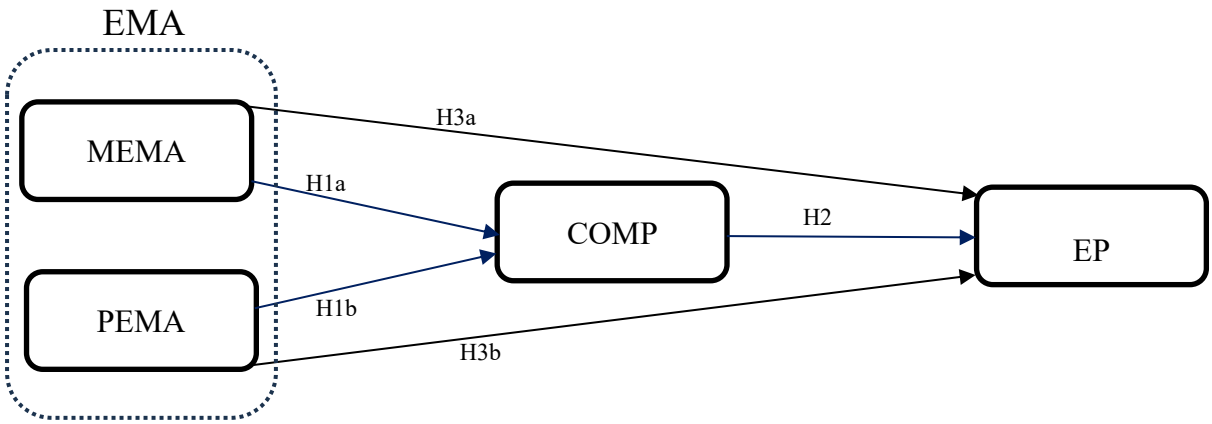
H4b: PEMA will positively affect EP through COMP

3.2.9 Conceptual Framework

The relationships among EMA, COMP, and EP, as hypothesised, are presented in a conceptual framework displayed in Figure 3.1. The framework is supported by NRBV theory and by empirical results from prior studies (Ong, Kasbun, Abdul Rahman, Meero, & Teh, 2022; Deb, 2023; Abdul Rasit, Bahari, & Alam, 2023; Hasan, Waghule, & Hasan, 2024). It shows that the relationship between EMA and EP is both direct and indirect through COMP (i.e. MEMA → COMP → EP and PEMA→ COMP → EP). This is a mediation in which EMA impacts COMP, which in turn affects EP. The direct effect of MEMA on COMP is captured in hypothesis H1a, while the impact of PEMA on COMP is represented in hypothesis H1b. The direct effect of MEMA on EP is labelled as hypothesis H3a, while the direct impact of PEMA on EP is labelled as H3b. In hypothesis H2, the direct effect of COMP on EP is displayed. The indirect effect of MEMA through COMP, referred to as hypothesis H4a, is the mediation of MEMA in the relationship between EMA and EP. Hypothesis H4b also demonstrate the mediation of COMP in the relationship between EMA and EP.

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Figure 3.1: Conceptual framework for the mediating role of competitive advantage



Note. Figure 3.1 presents the conceptual framework for the mediating role of competitive advantage on the influence of EMA on EP. EMA comprises two variables (MEMA and PEMA). **MEMA** refers to monetary environmental management accounting, while PEMA stands for physical environmental

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management accounting. **COMP** indicates competitive advantage, and **EP** stands for environmental performance. Author's own analysis (2025)

3.3 Methodology

Purposive sampling was used to select manufacturing firms from six towns (Tema, Accra, Kumasi, Takoradi, Winneba and Tamale) in Ghana. Manufacturing firms are the fourth-largest contributors to carbon pollution in Ghana, and carbon emissions are the most serious air pollutant. This makes the choice of manufacturing companies a good one for the study of the impact of sustainability interventions on EP (Ong, Kasbun, Abdul Rahman, Meero, & Teh, 2022). Akin to previous studies (Deb, Rahman, & Rahman, 2023; Liu & Zhang, 2022), 5 questionnaires were sent to 98 firms (i.e. 490 questionnaires) targeting chief executive officers, finance controllers, plant managers, human resource managers, and other departmental managers. They are deemed to be appropriate participants in such surveys due to their knowledge about the routine operation of their firms. Furthermore, the choice of these respondents per firm in this survey permits the avoidance of single-respondent bias because it facilitates a triangulation of information (Liu & Zhang, 2022). Of the total of 490 questionnaires administered to manufacturing firms, 257 responses were obtained from 85 firms, representing a 52.45% individual-level response rate (86.73% firm-level response rate). Due to incomplete information, 26 responses were rejected, leaving 231 valid responses pertaining to 85 firms. This response rate falls within the range of previous empirical studies on EMA. For instance, whereas Nartey (2018) had a response rate of 88.4% in a study in Ghana, Ong, Kasbun, Abdul Rahman, Meero, & Teh (2022) recorded as low as a 23.2% response rate in their research on Malaysian accountants.

The study uses PLS-SEM as an analytic technique because the data collected is not normally distributed (Hair, Risher, Sarstedt, & Ringle, 2019). PLS-SEM is robust for non-normally distributed data. Besides, it is suitable for both causal explanations and predictions in estimating statistical models (Hair et al., 2019).

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To enable firm-level analysis, the study followed the recommendation of Miao, Cai, & Xu (2012) by averaging the scores of each indicator for all respondents from each firm, resulting in 85 firm-level responses. Although this sample size is small (for covariance-based SEM), it is sufficient for an analysis using PLS-SEM, and many authors have indicated that in PLS, the minimum sample size can be as small as 20 (Palos-Sanchez, Martin-Velicia, & Saura, 2018; Ching & Newsted, 1999).

In consonance with Kock, Berbekova, & Assaf (2021), common method bias was prevented using procedural controls and psychological separation techniques. With the procedural controls, the questionnaires were designed to ensure anonymity of respondents and clarity of statements. Piloting of the questionnaires with a manufacturing firm facilitated the rephrasing of some statements to enhance clarity. Furthermore, in line with Knock (2015), a full collinearity test was conducted to statistically assess common method bias. If the VIFs exceed 3.3, then common method bias exists in the model. The VIF test of the relationship between the latent variables indicates the absence of this bias (see Table 3.1).

Moreover, non-response bias (Wang, 2019) was assessed using SPSS software by comparing the averages of responses of 40 early respondents (firm-level responses) against those of 40 late respondents. The result of the T-tests, as evidenced by the insignificant p-values, shows the absence of non-response bias (Table 3.2).

Table 3.1: Assessment of Common Method Bias Using VIF

Latent Variables Relationship	VIF
COMP -> EP	1.310
MEMA -> COMP	2.047
MEMA -> EP	2.048
PEMA -> COMP	2.047
PEMA -> EP	2.334

Note. Table 3.1 presents the result of the common method bias assessment using VIF. **VIF** means variance inflation factor. **MEMA** is monetary environmental management accounting assessed with 8 indicators, **PEMA** is physical environmental management accounting assessed with 4 indicators, and **COMP** indicates competitive advantage measured using 9 manifest variables. **EP** stands for environmental performance measured with 4 indicators.
Source: Author's own construct (2025)

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Table 3.2: Estimation of Non-Response Bias

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
ME_MEMA - ML_MEMA	0.097	1.331	0.211	-0.329	0.523	0.46	39	0.648
ME_PEMA - ML_PEMA	0.075	1.629	0.258	-0.446	0.596	0.291	39	0.772
ME_COMP - ML_COMP	0.005	1.707	0.270	-0.541	0.551	0.019	39	0.985
ME_EP - ML_EP	0.244	1.194	0.189	-0.138	0.626	1.291	39	0.204

Note. Table 3.2 presents the result of non—response bias where **ME_MEMA** = Mean of MEMA indicators for early respondents and **ML_MEMA** = Mean of MEMA indicators for late respondents. **ME_PEMA** is the Mean of PEMA indicators for the early respondents and **ML_PEMA** is the mean of PEMA indicators for late respondents. **ME_COMP** is the Mean of COMP indicators for early respondents, and **ML_ COMP** is the mean of COMP indicators for late respondents. **ME_EP** is the Mean of EP indicators for early respondents and **ML_ EP** is the mean of EP indicators for late respondents.
Source: Author's own construct (2025)

The constructs were measured using questionnaires with statements ranked on a 7-point Likert scale, having 1 as the lowest score and 7 as the highest score. Rahman et al. (2021) affirm the superiority of a 7-point Likert scale over the 5-point scale concerning indices such as respondent preference, discriminating power, reliability, and validity.

EMA (consisting of PEMA and MEMA) was measured by adopting the scale of Liu & Zhang (2022) and Ferreira, et al. (2010). MEMA comprises 8 statements, whilst PEMA is made up of 5 statements. EP was measured by adopting the 4 statements from Wang (2019). COMP was measured by combining the statements in the scales of Rahman et al. (2021) and Leonidou, et al. (2013). This combination was necessary to capture statements assessing cost-leadership COMP, product differentiation COMP, and focus COMP, as identified by Porter (1980). The scale of Rahman et al.

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(2021) includes 5 statements measuring cost leadership COMP, while the scale of Leonidou et al. (2013) has 6 statements predominantly measuring product differentiation and focus.

3.4 Results and Discussion of Results

3.4.1 Demographic profile

As shown in Table 3.3, the sample comprises 74.12% males and 25.88% females. This implies that the sample under study is dominated by males. This is a probable reflection of male dominance at the senior management level in the manufacturing sector of Ghana.

Concerning age, 34.12% of respondents were below 35 years, and the rest (65.89%) were 35 years and above. This illustrates the excess of older workers over younger ones, which is not astonishing given the focus on senior managers in the administration of questionnaires.

Again, 62.35% of the respondents had a first degree, while 37.65% had a master's degree. This implies that the respondents were well educated, which increases the likelihood of their understanding of the questions. Respondents studied Accounting, Finance, or Commerce (49.41%), Marketing (5.88%), Supply Chain Management (12.94%), Economics (10.59%), Agriculture (7.06%) and other disciplines (14.12%). The diversity of their field of study demonstrates that environmental sustainability necessitates expertise from multiple disciplines for successful implementation.

With regards to the type of manufacturing, 4.71% of the firms were engaged in building material production (i.e. cement, roofing sheets and steel), 62.35% of them were in food processing (i.e. beverages, salt, chocolate, etc.), 17.65% was manufacturing beauty products, 3.53% was producing textiles, and 11.76% were in pharmaceutical production. This variety enriched the responses with rich experiences from different subgroups in the manufacturing sector. Almost all of the companies (98.82%) are private, and all sample firms are large enterprises with over 100 employees.

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Table 3.3: Sample and details of organisations

Sample (Firm level =85, individual = 231)		
Variables	frequency	%
Sex		
Male	171	74.12
Female	60	25.88
Age		
< 25 years	14	5.88
25-34 years	65	28.24
35-44 years	111	48.24
45 years and above	41	17.65
Education		
1st Degree	144	62.35
Masters	87	37.65
PhD	0	-
Discipline		
Accounting /Finance/ Commerce	114	49.41
Marketing	14	5.88
Supply Chain Management	30	12.94
Economics	24	10.59
Agriculture	16	7.06
Others	33	14.12
Manufacturing type		
Building Materials	4	4.71
Food Processing	53	62.35
Beauty product manufacturing	15	17.65
Textile manufacturing	3	3.53
Pharmaceutical	10	11.76
Ownership Structure		
Privately Owned	84	98.82
State-Owned	1	1.18
Company Size		
Small (1-30 employees)	0	0.00
Medium (31 to 100 employees)	0	0.00
Large (Over 100 employees)	85	100

Note. Table 3.3 presents the demographic profile, showing the sex, age range, academic qualification, discipline studied, and the sector of operation of the respondents.
Source: Author's own construct (2025)

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3.4.2 Reliability and Validity

Reliability and convergent validity were measured using composite reliability (CR), Cronbach's alpha (α), and average variance extracted (AVE) of latent variables, as well as the factor loadings of each manifest variable (Deb, Rahman, & Rahman, 2023). According to Hair, et al. (2019) a benchmark ranging from 0.70 to 0.90 is "satisfactory to good" for CR and α, while an AVE of 0.50 or higher is acceptable, and a factor loading exceeding 0.70 is appreciable.

The results show that the factor loading of all items measuring EP, PEMA, MEMA and COMP (apart from COMP1 and COMP2) is greater than 0.70. COMP1 and COMP2 were removed from the model because they were not properly defining the latent variable COMP. Besides, apart from MEMA7, all manifest variables had a mean score above 5, indicating that the firms undertake most of the practices relating to EP, PEMA, MEMA and COMP. With MEMA7 (my firm creates and uses environment-related cost accounts), the average score implies that the firms neither agree nor disagree. Moreover, EP, COMP, MEMA and PEMA have CR and α > 0.70 and AVE > 0.50. This implies that the convergent validity and reliability of the model are satisfied.

Table 3.4: Reliability and Convergent Validity of the Constructs

Statements	Code	Mean	FL	P values
Firm Environmental Competitive Advantage	COMP (CR = 0.938, α = 0.858, AVE = 0.627			
The use of innovative technology helps to shape the strategy that reduces the overall environmental cost	COMP3	5.500	0.830	0.000
Early adoption of an environmental management system supports environmental cost savings.	COMP4	5.488	0.788	0.000
The environmental cost advantage can be achieved through the application of environmental accounting	COMP5	5.595	0.790	0.000
Being environmentally conscious can lead to substantial cost advantages	COMP6	5.602	0.792	0.000
Our company has realised significant cost savings by improving the environmental quality of our products/services	COMP7	5.265	0.776	0.000
By regularly investing in new eco-friendly technologies, processes and strategies, our company can be a leader in the market	COMP8	5.560	0.813	0.000
Our company can enter lucrative new markets by adopting environmental strategies	COMP9	5.700	0.813	0.000
Our company can increase service quality by making its current processes more environmentally friendly	COMP10	5.476	0.714	0.000

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Statements	Code	Mean	FL	P values
Reducing the negative environmental impact of our company's activities will lead to a quality improvement in its products/services	COMP11	5.597	0.801	0.000
Environmental Performance	EP (CR = 0.875, α = 0.810, AVE =0.638)			
My company has achieved important environment-related certifications	EP1	5.583	0.748	0.000
My company has regularly achieved targets imposed on energy conservation, recycling or waste reduction	EP2	5.325	0.873	0.000
Due to its environmentally friendly practices, my company has saved a significant amount of money in the past (not including the achievements in terms of energy conservation, recycling or waste reduction)	EP3	5.107	0.818	0.000
On average, the overall environmental performance of my company has improved in the past five years	EP4	5.667	0.750	0.000
Monetary environmental management accounting	MEMA (CR = 0.923, α = 0.905, AVE = 0.601)			
My firm identifies environment-related costs	MEMA1	5.762	0.748	0.000
My firm estimates environment-related contingent liabilities (e.g. EPA fines)	MEMA2	5.381	0.769	0.000
My firm classifies environment-related costs	MEMA3	5.167	0.790	0.000
My firm allocates environment-related costs to production or service processes	MEMA4	5.160	0.793	0.000
My firm allocates environment-related costs to products or services	MEMA5	5.061	0.784	0.000
My firm introduces or improves environment-related cost management	MEMA6	5.537	0.830	0.000
My firm creates and uses environment-related cost accounts	MEMA7	4.667	0.746	0.000
My firm develops and uses environment-related key performance indicators	MEMA8	5.272	0.738	0.000
Physical EMA	PEMA (CR = 0.905, α = 0.859, AVE = 0.705)			
My firm carries out product/service life cycle cost assessments	PEMA1	5.095	0.862	0.000
My firm does product inventory analyses (i.e. the specification of the types and quantities of materials and energy required and the amount of residues released to the environment)	PEMA2	5.310	0.857	0.000
My firm does product/service impact analyses (i.e. assessment of the environmental effect of products or services)	PEMA3	5.381	0.888	0.000
My firm does product/service improvement analysis (i.e. identification of opportunities for reduction of environmental impact)	PEMA4	5.714	0.746	0.000

Note. Table 3.4 presents the results of the *measurement model which assesses the reliability and convergent validity of the constructs.* **MEMA** is monetary environmental management accounting assessed with 8 indicators, **PEMA** is physical environmental management accounting assessed with 4 indicators and **COMP** indicates competitive advantage which was initially measured using 11 manifest variables. However, ***COMP1*** *and* ***COMP2*** *were deleted from the model because their factor loading is < 0.5;* **EP** stands for environmental performance measured with 4 indicators. ***AVE****= Average variance extracted,* ***FL****= factor loading and* ***CR*** *= Composite Reliability.*
Source: Author's own construct (2025)

Heterotrait-monotrait (HTMT) ratio of correlations enabled the assessment of discriminant validity. Henseler, et al. (2015) recommends a threshold of 0.90 or below. As shown in Table 3.5 the HTMT values of all the constructs fall below 0.90 and therefore affirm discriminant validity.

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Table 3.5: Discriminant Validity of the Constructs

	COMP	EP	MEMA
EP	0.512		
MEMA	0.379	0.706	
PEMA	0.522	0.815	0.812

Note. Table 3.5 presents the results of the discriminant validity assessment using HTMT. **MEMA** is monetary environmental management accounting assessed with 8 indicators, **PEMA** is physical environmental management accounting assessed with 4 indicators, and **COMP** indicates competitive advantage measured using 9 manifest variables. **EP** stands for environmental performance measured with 4 indicators.
Source: Author's own construct (2025)

3.4.3 Model Performance

Existing studies (Deb, Rahman, & Rahman, 2023; Ong, Kasbun, Abdul Rahman, Meero, & Teh, 2022; Rehman, Elrehail, Poulin, Shamout, & Alzoubi, 2023) used R-square (R^2), f-square (f^2) and Q-square (Q^2) to examine the performance of the PLS-SEM model. Regarding thresholds, f^2 values higher than 0.02, 0.15 and 0.35 are deemed small, medium and large f^2 effect sizes, respectively. Similarly, R^2 values of 0.25, 0.50 and 0.75 are considered weak, moderate and substantial. Furthermore, Q^2 values higher than 0, 0.25 and 0.50 indicate "small, medium, and large predictive relevance of the PLS-path model.

The results reveal that the R^2 value of the path MEMA to COMP and that of PEMA to COMP is 0.240, while the R^2 value of all paths to EP is 0.523. By implication, the model possesses a small to moderate in-sample explanatory power. In other words, at least 24% of the variation in COMP can be explained by MEMA and PEMA, while at least 52.3% of the variation in EP can be explained by MEMA, PEMA and COMP.

Additionally, the model possesses the smallest f^2 effect size of 0.000 vis-à-vis the influence of MEMA on COMP and the highest f^2 effect size of 0.165 on the impact of PEMA on EP. This parameter signifies that the removal of MEMA as an exogenous construct does not affect the R^2 value of its association with COMP. Besides, the removal of PEMA has a moderate effect on the R^2 value

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of its association with COMP. Similarly, the removal of MEMA and COMP has a small effect size on the R^2 values (0.068 and 0.040, respectively) of their relationship with EP. However, the removal of PEMA has a substantial influence on the R^2 value (0.165) of its association with EP. This consolidates the relevance of PEMA in the model. Furthermore, the model's Q^2 value of 0.179 for COMP indicates a moderate predictive accuracy whilst a Q2 value of 0.461 for EP shows a close to large predictive accuracy. The results are displayed in Table 3.6.

Table 3.6: Model's Performance

	R^2	f^2	Q^2
MEMA -> COMP	0.240	0.000	0.179
PEMA -> COMP		0.140	
MEMA -> EP	0.523	0.068	0.461
PEMA -> EP		0.165	
COMP -> EP		0.040	

Note. Table 3.6 presents the result of the model's performance. It shows the extent to which variations in dependent variables COMP and EP are explained by independent variables **MEMA**, **PEMA** and **COMP**. **MEMA** is monetary environmental management accounting assessed with 8 indicators, **PEMA** is physical environmental management accounting assessed with 4 indicators and **COMP** indicates competitive advantage measured using 9 manifest variables. **EP** stands for environmental performance measured with 4 indicators.
Source: Author's own construct (2025)

3.4.4 Hypotheses testing

Table 3.7 contains the results of the hypothesis testing. It indicates that only one (PEMA) of the two constituents of EMA is significantly and positively related to COMP ($\beta = 0.046$, $p = 0.007$) thereby supporting H1b. To elaborate on this, an increase in PEMA by a unit results in an enhancement in COMP by 0.46, holding all other factors constant. MEMA has no significant association with COMP. This implies that MEMA interventions (such as the identification and allocation of environmental costs and the improvement in environmental-related cost management) do not provide a competitive advantage to firms. Rather, it is interventions relating to PEMA (i.e. inventory analysis and product impact analysis) that result in COMP.

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Regarding the effects on EP, both components of EMA (PEMA and MEMA) have a significantly positive relationship with EP. Specifically, the parameters about the effect of MEMA on EP are $\beta = 0.25$ and $p = 0.037$, whilst those of PEMA on EP are $\beta = 0.43$ and $p = 0.000$. This finding is akin to that of previous studies (Aftab, Abid, & Cucari, 2022; Nisar, et al., 2021; Deb, Rahman, & Rahman, 2023) which concluded that both PEMA and MEMA positively and significantly impacted EP. The finding reinforces the fact that firms that are seeking to reduce their ecological footprint should engage in EMA. To go beyond abiding by legal requirements to enhance their ecological performance, it is appropriate for manufacturing firms (especially the larger ones) to embrace international certification in environmental management. This ensures constant monitoring not only by the government (for regulatory compliance) but also by internationally certified assurance providers, resulting in high environmental performance.

Regarding the mediating role of COMP on the influence of EMA on EP, the results indicate that there is no such mediation. This is because the indirect effects are insignificant (i.e. COMP has no significant association with EP). It is only the direct effect of EMA on EP that is significant. The finding implies that firms implementing EMA can achieve improved environmental performance without having a competitive advantage. This finding is consistent with the assertion of Ma (2000) who argues that there is the possibility of achieving superior performance without a competitive advantage. It is expedient to recommend that firms should be mindful of cost in the quest to enhance EP because such expenses do not give a competitive advantage. Therefore, an equilibrium ought to be reached between the cost of implementing EMA and the benefit thereof (enhanced ecological performance) to ensure the overall success of an organisation. The table below encompasses the results of hypothesis testing.

Table 3.7: Result of Hypothesis Testing

Effects	Path in SEM	(β)	P values	Decision
Direct effects	MEMA -> COMP	0.04	0.766	H1a not supported
	PEMA -> COMP	0.46	0.007	H1b supported
	COMP -> EP	0.15	0.199	H2a not supported

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	MEMA -> EP	0.25	0.037	H3a supported
	PEMA -> EP	0.43	0.000	H3b supported
Indirect effects	MEMA -> COMP -> EP	0.01	0.861	H4a not supported
	PEMA -> COMP -> EP	0.07	0.244	H4b not supported
Total effects	MEMA -> EP	0.26	0.017	
	PEMA -> EP	0.5	0.000	

Note. Table 3.7 presents the results of the hypothesis testing. **MEMA** is monetary environmental management accounting assessed with 8 indicators, **PEMA** is physical environmental management accounting assessed with 4 indicators and **COMP** indicates competitive advantage measured using 9 manifest variables. **EP** stands for environmental performance measured with 4 indicators.
Source: Author's own construct (2025)

3.4.5 Differential Impact of Monetary Environmental Management Accounting and Physical Management Accounting

Table 3.8 compares the effects of MEMA and PEMA on COMP and EP. Comparing the direct impact of MEMA ($\beta = 0.04$, $p > 0.05$) against the effect of PEMA ($\beta = 0.46$, $p < 0.01$) on COMP, one observes that only PEMA significantly influences COMP. Moreover, the effect size of PEMA **($f^2 =$ 0.**168) on EP is 2.4 times larger than that of MEMA **($f^2 = 0.068$)**. This implies that PEMA contributes more to the variation in EP. This position is further strengthened by the 65.8% contribution of PEMA to the total effect on EP against the 34.2% contribution attributable to MEMA. However, the relationship between PEMA/MEMA and EP is not mediated by COMP.

Practically, this result suggests that more resources should be allocated to PEMA-driven initiatives (e.g. product life cycle cost assessment, environmental impact assessment and product improvement analysis) to use PEMA as a strategy that leads to COMP. However, because COMP has no mediating effect, it is prudent to limit the investment in strategies that assume COMP lead to EP.

Table 3.8: Differential Effects of MEMA and PEMA

Parameter	MEMA	PEMA	Remark
Direct Effect (X → COMP)	$\beta = 0.04$ (not significant)	$\beta = 0.46$**	Only PEMA significantly influences COMP.
Direct Effect (X → EP)	$\beta = 0.25$* (weaker)	$\beta = 0.43$*** (stronger)	PEMA impacts EP more.
Effect Size (f^2, X → EP)	0.068 (small)	0.168 (small-medium)	PEMA explains 2.4 times more EP variance than MEMA.

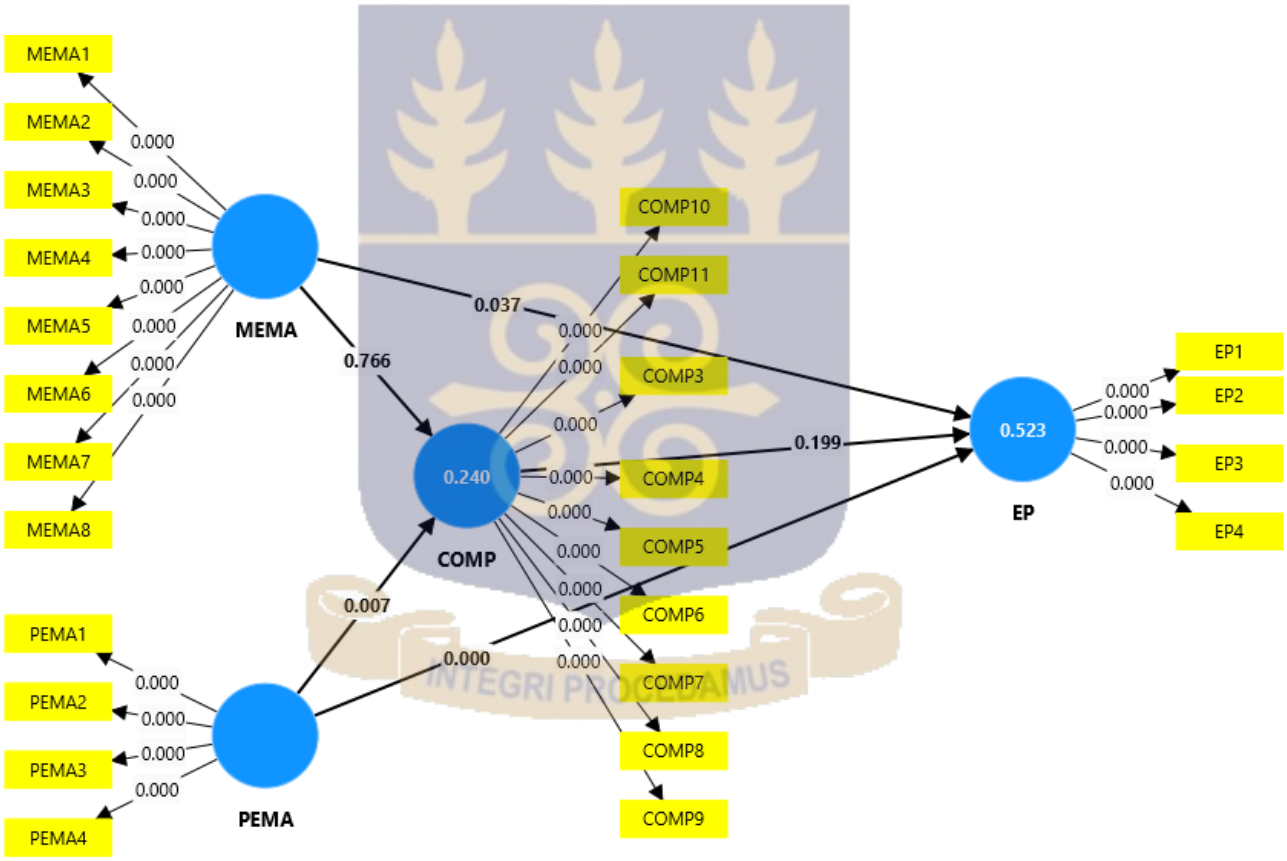
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Indirect Effect	β = 0.01 (no mediation)	β = 0.07 (no mediation)	None has a mediating effect
Total Effect Contribution	34.2% of the total effect	65.8% of the total effect	PEMA contributes more to the effect on EP

Note. Table 3.8 compares the differential effects of MEMA and PEMA on COMP and EP. **MEMA** is monetary environmental management accounting, **PEMA** is physical environmental management accounting, and **COMP** indicates competitive advantage. **EP** stands for environmental performance measured with 4 indicators. Also *** shows $p < 0.001$, ** $p < 0.01$ and * $p < 0.05$.
Source: Author's own construct (2025)

A graphical representation of the results, as an output of SmartPLS version 4 is displayed in Figure 3.2.

Figure 3.2: Structural Equation Model on the Mediation of Competitive Advantage



Note. Author's own work (2025)

3.4.6 Discussion of results

This study was designed to address two interlinked questions derived from the NRBV (Hart, 1995; Hart & Dowell, 2011): first, whether the components of EMA exert differential effects on COMP and EP and second, whether EMA functions as a strategic capability in line with NRBV principles. Our findings provide clear answers that advance the theoretical discourse on sustainable operations.

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The findings yield strong evidence for differential effects between EMA's physical (PEMA) and monetary (MEMA) components. PEMA demonstrates a dual positive impact, significantly enhancing both COMP and EP. In contrast, MEMA influences only EP directly, with no significant effect on COMP. PEMA partially aligns with the NRBV by creating market advantages through cost leadership or differentiation. Conversely, MEMA appears to serve an operational, compliance-oriented function. This demonstrates that the EMA is not a monolithic construct, so its aggregation in research obscures the nuances embedded in its heterogeneous nature.

Regarding the second question, the findings partially support repositioning PEMA as a strategic NRBV capability which creates competitive advantage and improved ecological performance simultaneously. However, the mediated pathway (EMA→COMP→EP) central to the NRBV, where advantage drives environmental performance, is not supported. This is because COMP does not significantly affect EP. It suggests that possessing an environmental capability (such as PEMA) is a crucial first step that can yield both a competitive edge and better environmental output. However, the transformation of competitive gains into environmental performance is not automatic, as it may depend on other factors.

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3.5 Conclusion

In conclusion, this chapter highlights the crucial role of EMA in enhancing EP among manufacturing firms while indicating the absence of the mediating role of COMP on the influence of EMA on EP. Through a survey targeting senior officers of these firms, responses were analysed using PLS-SEM. SmartPLS software and SPSS were employed in the analysis. Importantly, the research mitigates common method bias and assesses non-response bias to ensure that its findings are reliable.

The findings reveal that while PEMA contributes to both COMP and EP, MEMA only affects EP directly. Competitive advantage does not serve as a mediator in this model, implying that firms can

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improve their environmental performance through EMA without this enhancement translating into a competitive advantage. This outcome is consistent with Ma's (2000) perspective that firms can achieve high performance without COMP. This understanding of the dynamics between EMA, COMP, and EP fills a gap in the literature, reinforcing the fact that firms can pursue and accomplish sustainability goals without securing a competitive edge. The findings suggest that while COMP is valuable, it is not an absolute requirement for firms seeking to meet environmental targets. Rather, by adopting EMA and embracing sustainable practices, manufacturing firms can make meaningful strides towards sustainability.

3.6 Policy Implications

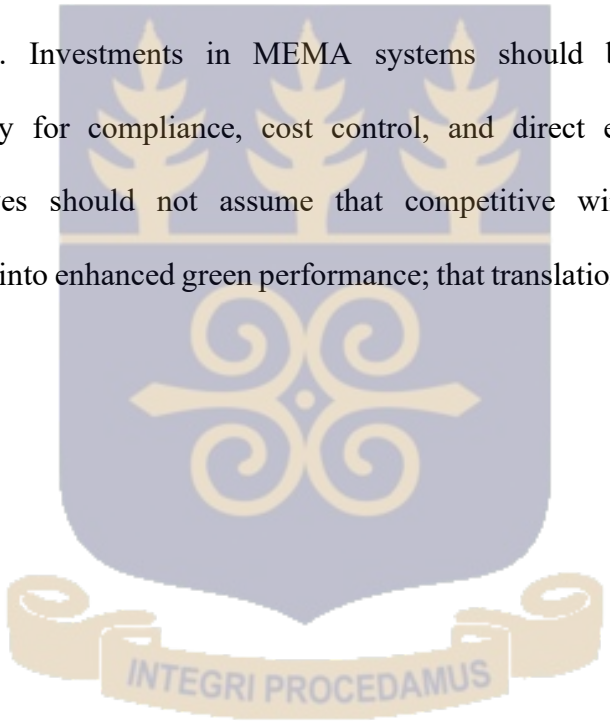
The implications of this research are substantial for policymakers, theory and business leaders. For policymakers, these findings suggest that adopting EMA should be incentivised in manufacturing firms. This could be done through training on sound EMA practices and the offering of tax incentives that attract investment into environmental management technologies. Given the commitment of the government to its nationally determined contribution, this incentive is crucial in ensuring a win-win situation for the government and manufacturing firms. Ultimately, a substantial milestone of environmental gains can contribute to the broader objective of climate change mitigation, a pressing priority on the global agenda. In Ghana, where manufacturing firms significantly contribute to pollution, any policy that diminishes their environmental footprint is particularly relevant. By promoting EMA in firms, the government will be indirectly supporting them to abide by environmental standards, but the cost of achieving that must be moderate enough to encourage full compliance. It is worth reiterating that, in addition to incentives, the government must enforce compliance with existing laws protecting the environment. This is because law enforcement is established as a significant driver of EMA in firms.

Theoretical and Practical Implications

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Theoretically, this study makes two key contributions. First, it empirically validates the heterogeneous nature of environmental capabilities, moving beyond treating EMA as a unitary construct. Second, it refines the NRBV's logic by showing that while certain environmental capabilities (PEMA) are sources of advantage, the proposed link from advantage to superior environmental performance is not automatic. This invites future research to identify the moderators that enable or inhibit this cycle.

For practitioners, PEMA should be recognised as the strategic capability within EMA. Investing in lifecycle assessment, material flow analysis, and eco-design is likely to yield both market and environmental returns. Investments in MEMA systems should be managed with different expectations—primarily for compliance, cost control, and direct environmental improvement. Furthermore, executives should not assume that competitive wins from sustainability will automatically translate into enhanced green performance; that translation is may require other factors.



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CHAPTER FOUR

The Role of Carbon Management Accounting and Carbon Management Strategies in Enhancing Environmental Performance: A Case of Power Generators

Abstract

The main objective of this study is to explore how CMA relates to carbon management strategies to improve carbon performance in the high carbon-emitting sectors of Ghana. This is achieved by answering questions on why power generators engage in CMA practices, the carbon-related risks and opportunities they face, and how CMA practices relate to carbon management strategies to address these risks and opportunities while improving carbon performance. Using an exploratory case study method to study two power-generating companies (15 interviews involving 24 senior management personnel), the findings indicate that the main factors that motivated CMA practices include pressure, cost reduction, and the quest for competitive advantage. Regarding carbon risks, the findings show that the possibility of sanctions for non-compliance with regulations constitutes the highest risk to which both firms were exposed. Besides, although there are opportunities for investment in renewable energy, unfavourable economic indicators hinder Ghana from fully benefiting. As a contribution, the thesis indicates that debt finance and government ownership drive CMA adoption, carbon strategy of compliance and improve carbon performance.

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It is recommended that favourable economic conditions be created by the Government of Ghana to accelerate investments in renewable energy.

4.1 Introduction

Of all the types of environmental pollution, air pollution is the most destructive and has the most adverse impact on terrestrial beings (Manisalidis, Stavropoulou, Stavropoulos, & Bezirtzoglou, 2020; World Bank, 2023). Greenhouse gas (GHG) emissions are major contributors to climate change (Prajogo, Murwaningsari, & Mayangsari, 2023; Elsayih, Datt, Tang, Hamid, & Varua, 2023; UNFCCC, 2016). The dominant type of GHG is carbon emissions, so carbon emissions are often used as a synonym for GHG (IPCC, 2021).

Climate change is manifested through extreme weather events and changing weather patterns (United Nations, 2023; Orgeret, et al., 2022; Hall & Crosby, 2022). In recent times, flooding in Africa has displaced 4 million people, inundated millions of hectares of croplands, and destroyed hundreds of thousands of livestock (Africa Center For Strategic Studies, 2024). While this incident is occurring, the Horn of Africa experienced the worst drought in 40 years, causing crop failures, livestock losses, famine and acute malnutrition in Kenya, Ethiopia, and Somalia (Rhoda, et al., 2025). Vis-à-vis agriculture, climate change is responsible for a 30 – 50% loss of agricultural productivity worldwide (Bibi & Azizur, 2023) with yield in maize dropping by 36% in Italy in 2003, and fruit and forage harvest falling to about 30% in France (Sarkodie, Ahmed, & Owusu, 2022).

Recognising the threat of climate change to terrestrial life, global leaders have been striving for its mitigation and adaptation to its effects (Sarkodie, Ahmed, & Owusu, 2022). Mitigation

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efforts are geared towards reducing GHG emissions globally, while adaptation seeks to minimise the adverse impacts of climate change (Sarkodie, Ahmed, & Owusu, 2022). Global strides towards this objective include the Kyoto Protocol, the inclusion of climate action into the SDGs (United Nations, 2023) and the signing of the Paris Agreement.

As part of Ghana's commitment to these global initiatives, the country is implementing several regulations and policies related to carbon. For example, in its Nationally Determined Contribution to the global response to climate change, Ghana seeks to reduce GHG emissions by 64 $MtCO_2e$ as early as 2030 (EPA, 2019) and to achieve net-zero emissions in 2070 through the decarbonisation of the energy and transport sectors. In this regard, the Government plans to switch from liquified crude oil (LCO) to natural gas as fuel for thermal plants, increase renewable energy sources, integrate nuclear power into the energy generation mix, use electric vehicles and electric stoves, introduce carbon capture, utilisation and storage technology, and embark on afforestation (Ministry of Energy, 2022). Additionally, in 2023, the Government enacted the Emissions Levy Act, 2023 (Act 1112), to impose a tax on greenhouse gas (GHG) emissions from the construction, manufacturing, mining, oil and gas, and electricity and heating sectors.

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Scholars are divided about the effectiveness of regulations in ensuring environmental sustainability. Some argue that strict environmental regulations discourage innovation, increase compliance costs, create entry barriers, distort market-based solutions and impede competitive advantage (Adler, 2000; Hahn, 1990; Yandle, 1989; Lomborg, 2021). Lomborg (2021) added that regulations are neither effective nor necessary for environmental protection. Other researchers support tougher regulations, contending that rigorous laws deter pollution, encourage innovative strategies, reduce costs, and enable firms to gain a competitive advantage

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(Porter & van der Linde, 1995; Stiglitz, 2019). These divergent views about the effectiveness of regulations have yielded a significant concentration of research on environmental regulation and disclosures and their effects on corporate environmental practices and performance (Burritt, Schaltegger, & Zvezdov, 2011; Bui & Fowler, 2019; Porter & van der Linde, 1995; Stiglitz, 2019; Lomborg, 2021) to the detriment of intrinsic business models warranting the inculcation of sustainability into business practices.

A third school of thought believes that (Porter & Kramer, Creating shared value, 2011; Zatini, Porta, & Za, 2025) researchers should be more interested in the underlying corporate strategies – not just the legal obligations - that create economic value for the firm while enhancing environmental and social values. More importantly, studies within the broader scope of environmental strategies and performance should explore how Carbon Management Accounting (CMA) supports functional environmental strategies to boost carbon-related environmental performance (EP) (Changalima, Rutatola, & Ntangeki, 2025; Tuesta, Cristina, & Vicente, 2021; Sitompul, Suroso, Sumarwan, & Zulbainarni, 2023; Prajogo, Murwaningsari, & Mayangsari, 2023). Unfortunately, there is limited research on the connection between corporate environmental sustainability strategies and firm EP. Therefore, in line with the integration of EMA into functional-level strategies to enhance EP, this aspect of the thesis narrows down to how CMA (a specific component of EMA) relates to carbon management strategies to reduce carbon emission (a type of EP). Theorising based on Natural Resource-Based (NRBV), institutional theory and stakeholder theory, this chapter of the thesis focuses on the specifics of EMA and EP to have an in-depth understanding of the role of CMA and CMS in improving EP.

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The main objective of this study is to explore the role of CMA and carbon management strategies on carbon-related environmental performance. Specifically, the study found out why power generators engage in CMA practices, the carbon-related risks and opportunities faced by them, and how CMA practices relate to carbon management strategies to affect EP. The rest of the study is organised as follows: Section 2 reviews the literature on CMA. Section 3 deals with the research method and the research findings, followed in Section 4. Finally, Section 5 discusses the results and concludes the study, highlighting its contributions, limitations, and recommendations for future studies.

4.2 Literature Review

4.2.1 Theoretical Review

This section begins a review of key concepts, including CMA, the motivation for CMA, carbon risks and opportunities, carbon management strategies, and carbon performance. It also discusses the Natural Resource-Based View (NRBV), stakeholder theory and institutional theory, whose propositions provide the basis for explaining the study's findings. NRBV (Hart S. L., 1995; Hart & Dowell, 2011) explains the internal proactive strategic motivations, risks and opportunities, and the linkages among CMA, carbon management strategies, and EP. Institutional theory clarifies the reactive responses of firms to external pressures, while stakeholder theory shows that firms can adopt both proactive and reactive stances to deal with stakeholder expectations (Donaldson & Preston, 1995; Mitchell, Agle, & Wood, 1997). Moreover, stakeholder theory (Freeman, 1984; Horisch, Schaltegger, & Freeman, 2020) emphasises the sources of pressure and the factors determining the prioritisation of responses (power, legitimacy, and urgency), while institutional theory (Dimaggio & Powell, 1983; Scott, 1995; Oliver, 1991) focuses on how rules and norms (industry standards, laws, and government policies) compel firms to act similarly or divergently.

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4.2.2 Carbon Management Accounting

Carbon accounting has a broader scope, which includes different disciplines and organisational hierarchies (Stechemesser & Guenther, 2012). Stechemesser & Guenther (2012) postulate that carbon accounting occurs at the international, national, industry, and corporate levels. However, when referring solely to carbon accounting at the corporate level, the term 'carbon management accounting' should be used instead of 'carbon accounting'. Prajogo *et al*. (2023) refer to CMA as an aspect of sustainability accounting that provides information on the carbon emission issues to managers of a company. It entails monitoring, recognition, and evaluation of GHG emissions at all levels of the value chain of an organisation (Prajogo, Murwaningsari, & Mayangsari, 2023). Tang and Luo (2014) refer to CMA as a significant step involved in the computation of the carbon footprint and inventory. It entails the collection, summary and measurement of GHG emissions to facilitate comparisons across reporting periods to enhance independent reviews for compliance and data accuracy. Furthermore, Ong *et al*. (2022) define CMA as a means to operationalise a firm's carbon strategy and policy to improve input efficiency, lessen risk and emissions, evade compliance costs, and enhance competitive advantage." These definitions virtually equate carbon accounting to CMA.

CMA is crucial in addressing climate change by providing data on carbon footprint and inventory for policy decisions across various levels. It aids in comparing emissions between firms (Bui & Fowler, 2019), reviewing carbon performance (Tang & Luo, 2014; Jona & Soderstrom, 2023), and monitoring emissions in real-time for prompt action to address system malfunctions and minimise GHG emissions. It permits the identification of risks and opportunities associated with carbon emissions (Ong, Kasbun, Abdul Rahman, Meero, & Teh, 2022). EMA, which includes CMA, meets stakeholders' environmental expectations by

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reducing waste and health risks (Dunk, 2007). Moreover, it assists investors in assessing investment risks and opportunities (Bui & Fowler, 2019; Bui, Wang, & Tekathen, 2024), influencing decisions to invest or divest (Krueger, Sautner, & Starks, 2020) to combat climate change. CMA is essential for project financing, as finance companies require emission data and mitigation measures at all levels of project development (IFC, 2012).

CMA plays a vital role in green marketing strategy by satisfying customer expectations about green products (Leonidou L. C., Leonidou, Fotiadis, & Zeriti, 2013; Fraj, Martínez, & Matute, 2011). A preference for green products over non-green products (Bui, Wang, & Tekathen, 2024) pushes suppliers to focus on providing ecologically friendly products; thus, reducing climate change. Nationally and internationally, greenhouse gas accounting informs stakeholders about the gravity of climate-related problems, guides emission control efforts, and aids policymakers in formulating policies (Schaltegger & Csutora, 2012).

4.2.3 Motivations for Carbon Management Accounting

Based on the NRBV, the prime motivation why organisations adopt CMA is to achieve competitive advantage. This is done through strategic mechanisms of pollution prevention, product stewardship and clean technology (Hart S. L., 1995; Hart & Dowell, 2011). According to Porter (1995) the competitive advantage could either be through cost leadership and/or differentiation. CMA permits close monitoring of carbon emissions, leading to operational efficiency and cost savings (Schaltegger & Csutora, 2012; Burritt, Schaltegger, & Zvezdov, 2011). Additionally, power generators could invest in eco-efficient fossil-fuel plants and renewable energy plants (Krueger, Sautner, & Starks, 2020) to differentiate their service as low-carbon as a way of enticing eco-conscious consumers.

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Stakeholder theory suggests that both internal and external factors motivate firms to adopt CMA. Internally, firms adopt CMA to align business strategies with stakeholder interests to improve performance (Donaldson & Preston, 1995). However, if they do not willingly take that step, external pressure from salient stakeholders forces them to address stakeholder expectations reactively (Mitchell, Agle, & Wood, 1997). These pressures could emanate from regulators, investors, environmental activists and non-governmental (Nartey, 2018; Burritt, Schaltegger, & Zvezdov, 2011).

Institutional Theory (Dimaggio & Powell, 1983; Scott, 1995; Oliver, 1991) affirms that firms adopt CMA because of regulations. It, however, added that the adoption of CMA could also be due to imitating other firms in the industry (Dimaggio & Powell, 1983) or following professional standards, or cultural beliefs (Scott, 1995). In addition to the above, some studies found that the industry in which a firm operates, the size of the organisation, its past performance, and its position in the value chain influence CMA adoption (Mata, Fialho, & Eugenio, 2018; Nartey, 2018).

4.2.4 Carbon risks and opportunities

Risk is the possibility of an event occurring that will adversely affect the achievement of objectives (COSO, 2013). ISO 31000 defines risk management as a series of "coordinated activities to direct and control an organisation about risk" (ISO, 2018). Carbon risks refer to the negative impacts that an entity may experience due to the emission of carbon during its operations (Körner, Michaelis, Spazierer, & Strüker, 2023). Regulatory risks, physical risks, market risks, and technological risks are the most critical carbon risks (Krueger, Sautner, & Starks, 2020; Körner, Michaelis, Spazierer, & Strüker, 2023; Elsayih, Datt, Tang, Hamid, & Varua, 2023). The need for technology to measure and reduce emissions results in

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technological risks, whilst the necessity to comply with laws poses regulatory risks. Market risks are associated with variations in carbon prices and the differences in the ability of firms to pass on carbon costs to customers (Krueger, Sautner, & Starks, 2020). Physical risk is the likelihood that severe weather conditions, due to climate change, will cause damage to business assets.

CMA practices provide firms with abundant opportunities, including the attraction of investment (Bui & Fowler, 2019), gaining legitimacy (Qian, Burritt, & Monroe, 2010) and competitive advantage (Ong, Kasbun, Abdul Rahman, Meero, & Teh, 2022). One of the objectives of the Paris Agreement is to direct the flow of funds toward "low greenhouse gas emissions and climate-resilient development" (UNFCCC, 2016). In pursuing this, governments and institutional investors prioritise green projects (Bui & Fowler, 2019) thereby enticing investment into renewable energy, carbon capture, and carbon sequestration technologies. Again, due to the global acceptance of the necessity to reduce GHG emissions, companies either conform to societal expectations concerning ecology, differentiate their products or manipulate public opinion (Bui & Fowler, 2019) to gain legitimacy. Effective CMA practices lead firms, especially power generators, to drastically reduce costs, which may result in a competitive advantage (Bui & Fowler, 2019).

4.2.5 Carbon Management Strategies

Carbon management strategies are policies for achieving net-zero carbon emissions through technologies and practices (IPCC, 2022). Net-zero emissions are achieved when "anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period" (SBTi, 2020). Carbon management strategies are anchored on governance, measurement, mitigation and remediation. Governance at the

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national level entails aligning policies with net-zero frameworks through regulations, while at the firm level, carbon governance is achieved through policies and institutional arrangements geared towards compliance with standards (SBTi, 2020). CMA facilitates carbon measurement (Tang & Luo, 2014; Prajogo, Murwaningsari, & Mayangsari, 2023). Carbon mitigation entails avoiding or reducing emissions into the atmosphere by balancing economic, environmental, and regulatory pressures (Bui, Wang, & Tekathen, 2024). Examples of emission avoidance strategies include using renewable energy instead of fossil fuel, preventing deforestation (UNCCD, 2025) and promoting recycling (ISSB, 2023; World Business Council for Sustainable Development and World Resources Institute, 2004). Finally, remediation is carried out to remove or offset carbon through afforestation or reforestation, direct air capture and sequestration, renewable energy projects or avoidance of deforestation (IPCC, 2022; Bui & Fowler, 2019). Reducing Emissions from Deforestation and Forest Degradation is an example a project financed by the United Nations that seeks to offset carbon emissions through forest conservation (IPCC, 2022).

4.2.6 Carbon Performance

Carbon performance refers to the effectiveness and efficiency in managing and reducing greenhouse gas (GHG) emissions and mitigating the impacts of climate change (IPCC, 2021; SBTi, 2020). Hoffmann & Busch (2008) propose four indicators for measuring the carbon performance of firms. They include carbon intensity, which assesses emissions per unit of output, and carbon dependency, which examines the proportion of fossil fuels in a firm's energy mix. Carbon dependency indicates the change in carbon performance over a period. Another indicator of carbon performance, espoused by Hoffmann & Busch (2008) is carbon exposure. It measures a firm’s sensitivity to climate policies, such as regulations and carbon taxes and describes the monetary implications of a business to carbon use over a period. Finally, carbon

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risk relates to the change in a firm's monetary carbon performance over a period (Hoffmann & Busch, 2008).

4.2.7 Natural Resource-Based View

According to NRBV, organisations achieve competitive advantage and improved performance by incorporating environmental sustainability into their core operations through pollution prevention, product stewardship and clean technology (Hart S. L., 1995; Hart & Dowell, 2011). Pollution prevention deals with reducing waste or emissions through tacit skills development, employee involvement and green teams (Hart S. L., 1995). Product stewardship entails the design of eco-friendly products or services to reduce the environmental impact of a product/service throughout its lifecycle. Finally, clean technology is going "beyond greening" strategies (i.e. pollution prevention and product stewardship) by developing and implementing innovations that reduce material and energy consumption (Hart & Dowell, 2011). NRBV extends the Resource-Based View (Barney J. , 1991) by demonstrating how companies can leverage natural resources, green capabilities and eco-innovations to outperform competitors while achieving higher environmental performance.

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Applied to the operation of power generators, the theory suggests that the motivation for adopting CMA is an internal and proactive step to gain a competitive advantage by minimising emissions and cutting costs (Kazemian, et al., 2022; Burritt, Schaltegger, & Zvezdov, 2011) through investment in eco-efficient fossil-fuel plants and renewable energy technologies (Krueger, Sautner, & Starks, 2020). This investment allows firms to mitigate carbon-related risks while deriving the opportunities associated with clean technologies. CMA permits power generators to track performance by comparing actual emissions against targets (Bui, Wang, & Tekathen, 2024).

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4.2.8 Stakeholder Theory

Stakeholder theory (Freeman, 1984; Horisch, Schaltegger, & Freeman, 2020) espouses four main ideas. To begin with, the theory posits that an organisation is a network of relationships among different stakeholders. A stakeholder is "any group or individual who can affect or be affected by an organisation" (Freeman, 1984). The second proposition of the theory is that managers' core duty is to create value for stakeholders by satisfying their (stakeholders') interests as far as feasible. It is acknowledged that these interests are varied and may be conflicting; therefore, Horisch, Schaltegger, & Freeman, (2020) prescribe the reliance on stakeholder salience to prioritise how to deal with stakeholder interests. According to stakeholder salience, preference should be given to stakeholders based on power, risks, vulnerability, urgency, implied contract, and legitimacy. The third postulation of the theory is the "integration thesis", which signifies that ethics and business are inseparably connected. Horisch, Schaltegger, & Freeman (2020) clarify that ethical considerations influence business decisions and vice versa. The fourth notion of the theory is that firms are established for purposes that extend beyond profit-making to ensure fruitful cooperation with stakeholders.

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These assertions imply that firms seek to address the interests of various stakeholders, rather than focusing solely on their shareholders, to maintain legitimacy and minimise risks (Krueger, Sautner, & Starks, 2020; Elsayih, Datt, Tang, Hamid, & Varua, 2023). Proactively, the theory suggests that firms need to actively engage with their stakeholders to align business strategies with stakeholder interests to improve performance (Donaldson & Preston, 1995). However, when firms fail to act proactively, pressure from salient stakeholders compels them to address stakeholder expectations reactively (Mitchell, Agle, & Wood, 1997). With firms operating in a high-polluting sector like power generation, salient stakeholders like governments, investors,

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customers, and activists bear the threat of sanctions, divestment, and boycotts, making the need for engagement imperative.

4.2.9 Institutional Theory

Institutional Theory (Dimaggio & Powell, 1983; Scott, 1995; Oliver, 1991) espouses the notion of isomorphism, indicating that firms in the same industry increasingly resemble each other in structure, practices or strategies due to coercive, normative, and mimetic pressures (but not because of efficiency or competition) to gain legitimacy. Using the metaphor of an 'iron cage', Dimaggio & Powell (1983) suggest that institutional rules trap organisations in a similar field, conforming to social legitimacy, without the ability to innovate or be different. Scott (1995) defined institutions as regulative (rules), normative (norms) and cultural-cognitive (beliefs) pillars that constrain the behaviour of firms. However, contrary to the postulation of Dimaggio & Powell (1983) that firms assume passive conformity, Scott (1995) argues that firms can actively resist, reinterpret or reshape institutional norms to serve their interests. Furthermore, Oliver (1991) states that organisations actively resist, negotiate or reshape institutional pressures through five strategies: acquiescence, compromise, avoidance, defiance, and manipulation. Acquiescence means full compliance with rules, while compromise entails partial compliance. Avoidance refers to circumventing rules, defiance is an open rejection of the rules, and manipulation constitutes a reshaping of regulations (Oliver, 1991).

The theory suggests that firms adopt CMA because of coercive pressures (regulations), mimetic pressures (imitating other firms in the industry) and normative pressures (professional standards) to achieve legitimacy (Dimaggio & Powell, 1983). It equally indicates that firms in the power generation industry are exposed to carbon regulatory risks. However, being active participants in the industry (Scott, 1995) that they can devise strategies to gain legitimacy,

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competitive advantage, attract green finance and improve environmental performance (Bui & Fowler, 2019).

4.2.10 Empirical review

There are numerous studies on CMA and climate change. For example, Burritt et al. (2011) examined the CMA practices of 10 leading German firms, using interviews and questionnaires to understand corporate practices regarding the collection, management, and communication of carbon-related information. The study revealed that CMA provides firms with an opportunity to gain a competitive advantage over their rivals. It also enables them to enhance the efficiency and effectiveness of information collection and dissemination. It facilitates the reduction of the carbon footprint of companies.

Similarly, Bui & Fowler (2019) studied carbon accounting practices and climate change strategies in two New Zealand power-generating companies, focusing on changes in climate change policy over ten years. The study found that the two companies had different strategic responses to changing climate change policy. These include avoidance, conformance, manipulation, negotiation, and differentiation. Another significant finding is the fact that carbon accounting significantly contributes to carbon reduction when it is integrated into the strategic responses of firms.

Literature also examined the relationships among functional imperative (defined as management actions geared towards achieving objectives), EMA and CMA using a sample of 445 respondents drawn from heads of waste management departments and other waste management employees of local governments in Indonesia. Using PLS-SEM for their analysis, Prajogo, Murwaningsari, & Mayangsari (2023) found that functional imperative positively

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relates to EMA and CMA. Besides, EMA positively influences CMA and mediates the relationship between functional imperative and CMA. The study reinforces the notion that firms engaged in EMA may equally undertake CMA, especially if they operate in carbon-intensive industries.

In a survey of institutional investors across 8 countries in Europe and North America, concerning their perception of climate risks, Krueger et al. (2020) found that climate risks influence their portfolio of investments. However, the companies do not divest from firms with exceedingly high carbon footprints. They pressurise those firms to minimise pollution and improve climate-risk disclosure.

In Ghana, Nartey's (2018) work assessing the determinants of CMA adoption involved a survey of 125 accountants. Both correlation analysis and binary regression analysis were conducted. The results indicate that organisational structure, strategy, environmental management accounting, technology, firm size, and perceived environmental uncertainty are positively associated with CMA. This suggests that both environmental factors and contextual imperatives influence CMA adoption. Akin to this finding is the result of Elsayih, et al. (2023) in a study that analysed 1035 firm-year observations from UK companies between 2011 and 2018. Internal governance is found to positively influence CMA. Equally, firms operating in industries with high carbon risks and opportunities are more likely to practice CMA. From both studies, it is possible to deduce that governance (including organisational structure and strategy), firm size, environmental uncertainty, and the risks and opportunities associated with a firm's operating industry affected CMA practices.

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The impact of CMA on financial performance has also been explored. In a sample of 350 European firms, the results of a multiple regression analysis indicate an inverse relation between indirect emissions and financial performance and a direct association between direct emissions and financial performance. This implies that an increase in emissions from sources owned and controlled by firms leads to better financial performance, while a reduction in emissions resulting from firms' supply chain decreases financial performance. Consequently, Tuesta, Cristina & Vicente (2021) discovered that firms compensate for direct emissions with indirect emissions to boost profitability (Tuesta, Cristina, & Vicente, 2021). In a review of 223 articles obtained from reputable journals indexed in Scopus involving firms from different countries and industries, the literature (Sitompul, Suroso, Sumarwan, & Zulbainarni, 2023) indicates that 59% of the articles show a positive association between CMA and firm performance, while 9% show mixed results (both positive and negative) in the association between CMA and financial performance.

Cadez and Guilding (2017) researched the association between carbon emissions, carbon cost, and product output volume. They also examined the factors that affect strategies aimed at reducing the impact of firms on climate change. Analysing data from 76 Slovenian firms, the study found that a change in sales leads to a direct proportionate change in carbon emissions of energy firms. With manufacturing firms, an increase in sales leads to a less-than-proportionate increase in carbon emissions. On the other hand, it was evident from the study that changes in fuel (from lignite to gas or biomass) and technology (investment in fuel-efficient boilers) enabled some of the sampled firms to reduce their carbon emissions. However, this move was marred by the fear of being dependent on foreign countries for the supply of gas and other energy-efficient coal. Therefore, the firms continue to bank on their domestic lignite.

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Tang & Luo (2014) propose 10 elements of a carbon management system in a paper using ordinary least squares and descriptive analysis to study 45 firms from nine sectors. These elements are categorised into four groups (i.e. carbon governance, emission tracking and disclosure, carbon operation, and reporting, engagement, and disclosure. The study also found that firms with high-quality carbon management systems achieved better carbon mitigation. Besides, the sampled firms actively carried out assessments of carbon risk and opportunities, enhanced their carbon programmes, set carbon reduction targets, and improved external disclosures. Finally, the authors postulate that the combination of governance, carbon tracking, internal processes, and communication was significant in improving decision-making in the firms.

In summary. this review indicates that governance and industry risks affect CMA adoption (Nartey, 2018; Elsayih et al., 2023) while robust information systems are essential for conducting CMA successfully (Körner et al., 2023). CMA improves operational efficiency and provides firms with a competitive advantage by ameliorating carbon-related data management (Burritt et al., 2011). Financially, CMA shows mixed results with profitability (Tuesta et al., 2021), but overall, it tends to positively influence firm performance (Sitompul et al., 2023). Firms adopt diverse strategies in response to climate policies (Bui & Fowler, 2019). It is also evident that institutional investors mount pressure on high-emitting firms to improve disclosures (Krueger, Sautner, & Starks, 2020).

4.3 Research method

This study resorts to an exploratory case study method (Bui & Fowler, 2019; Burritt, Schaltegger, & Zvezdov, 2011) to provide an in-depth understanding of how CMA relates to

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carbon management strategies to improve carbon performance in the high carbon-emitting sectors of Ghana**.** This section continues with a highlight of the sampling method and how data was collected and analysed.

4.3.1 Sampling

Purposive sampling and theoretical sampling were used in this research (Baškarada, 2014). Some firms were selected purposively after reviewing the literature on companies that contributed, through the provision of data, to the development of Ghana's Fourth National Greenhouse Gas Inventory Report. The list included regulatory agencies, which were excluded to narrow down to firms operating in high-GHG-emitting industries. This elimination was necessary because regulatory agencies acted as collators of information provided by principal-emitting firms. Another important consideration in the sampling was the focus on the energy sector because it contributed the most to carbon emissions in Ghana.

Furthermore, the sample size was reduced to firms with published sustainability reports and to firms that were desirous of actively participating in the research by providing staff for interviews and providing secondary data. Consequently, two firms were finally selected for the study.

Consistent with ethical agreements associated with interviews, the anonymity of the firms and of participants was maintained, leading to the naming of the companies as Company A and Company B. Company A generates power from a mix of hydro, thermal, and solar. It contributes 57% of Ghana's total energy generation capacity. Company B operates exclusively a thermal plant in Ghana. It is a subsidiary of an international company with a presence across the Middle East, Europe, and Africa. Although independently managed, all its generations are

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sold to Company A, which has a 10% minority shareholding in Company B. Company B accounts for 15% of Ghana's installed power production Capacity. This information about the profile of the two companies is presented in Table 4.1.

Table 4.1: Company profile

Organisation	Ownership	Hydro Generation	Thermal Generation	Solar Generation	Geographical Presence
Company A	State-owned	2-generation stations	5 plants	3 plants	Ghana
Company B	Partnership (90% privately owned and 10% state-owned)	None	1 plant	None	Ghana, but the parent company operates in Africa, Europe, Middle East

Note. Table 4.1 presents the profile of the companies which are the subject of this case study.
Source: Author's own construct (2025)

4.3.2 Data collection and analysis

A case study protocol, including an interview guide, a profile of prospective firms, and data collection procedures, was developed. The interview guide, aligned with IFRS S2, covered four areas: governance, strategy, risk management, and targets and metrics. Experts' input from the Climate Change Unit of the EPA led to modifications to the data collection instrument. Additional changes were made after engaging with interviewees to ensure clarity and fluency. Fifteen interviews, involving 24 interviewees, were conducted. It comprises two focus group discussions, one face-to-face interview, and twelve online interviews. The same questions were asked to two or more interviewees to triangulate their responses. While no consensus exists on sample size for qualitative studies (Marshall, Cardon, Poddar, & Fontenot, 2013; Coyne, 1997), recommendations suggest at least 20 to 30 interviewees for grounded theory studies and 15 to 20 for case studies (Marshall, Cardon, Poddar, & Fontenot, 2013). However, many researchers (Huerta, Petrides, & O'Shaughnessy, 2017; Qian, Burritt, & Monroe, 2018) conducted fewer

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interviews. Interviews were recorded, transcribed, and coded using NVIVO 14 software. Both manifest coding, which identified explicit themes, and latent coding, capturing implicit ones, were used. Table 4.2 provides further information on the interviews.

Table 4.2: Details of the interviews

Participants	Duration	Position (s)	Means of Interview
Interviewee 1	34 min	Director, Environment and Sustainable Development	Online
Interviewee 2	40 min	Senior Environmental Officer	Online
Interviewee 3	31 min	Manager, Environment and Social Impact	Online
Interviewee 4	62 min	Principal Environmental Officer	Online
Interviewee 5	39 min	Principal Risk Analyst	Online
Interviewee 6	30 min	Assistant Chemist	Online
Interviewee 7	35 min	Supervising Engineer	Online
Interviewee 8	40 min	Health, Safety and Environment Manager	Face to face
Interviewee 9	61 min	Acting Manager for Power Business	Online
Interviewee 10	51 min	Officer in charge of Solar installation	Online
Interviewee 11	43 min	Senior Environment and Sustainable Development Officer	Online
Interviewee 12	35 min	Technician Engineer	Online
Interviewee 13	33 min	Assistant Technician Engineer	Online
Focus Group 1	108 min	Environment Manager, Environment and Compliance Officer, Electrical Supervisor, Accountant, Head of Procurement, Management Accountant	Face to face
Focus Group 2	49 min	Finance Manager, Accountant, Project Finance Manager, Project Accountant	Face to face

Note. Table 4.2 presents the details of the interview, including the means through which the interview was conducted, the duration of the interview, the position of the interviewees in their organisation, and the type of interview.
Source: Author's own construct (2025)

This study obtained further data from multiple sources (Baškarada, 2014), seeking a repetition of evidence. These sources include sustainability reports and carbon footprint management reports of the firms under study. Data from these sources were triangulated against the responses from the interviews (Yin, 2003).

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Data analysis followed Yin's (2009) six-step case study process: planning, designing, preparing, collecting, analysing, and sharing. In addition, following Huerta *et al* (2017), a three-step approach was used in the analysis. In the first step, NRBV, institutional theory and stakeholder theory enabled the formulation of propositions about the motivation for CMA, carbon management strategies, and how CMA relates to the strategies to improve Carbon performance. Subsequently, the propositions were matched against the observed patterns, and finally, a comparison was made between the two cases.

More precisely, the study argues in line with NRBV, power generators adopt CMA based on internal drivers to gain a competitive advantage, reduce emissions, mitigate carbon risk and profit from carbon opportunities. Institutional theory explains that coercive, mimetic and normative pressures account for the similarities and differences in the strategies of the companies (i.e. institutional isomorphism). Finally, stakeholder theory supports the notion that power-generating firms will go beyond the interest of their shareholders to cater for the interests of salient stakeholders in devising strategies to enhance carbon performance.

4.4 Findings

The finding pertains to motivations for carbon management accounting in the sampled firms. In addition, they highlight carbon-related risks and opportunities inherent in the operations of the power generators. As part of the findings, the study unveils the carbon management strategies deployed by both firms and how CMA practices enhance the strategies. Finally, the study assesses the carbon performance of the firms.

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4.4.1 Motivations of Carbon Management Accounting

It is espoused that there is no single best motivation influencing why firms engage in CMA practices (Qian, Burritt, & Monroe, 2018; Burritt, Schaltegger, & Zvezdov, 2011). NRBV suggests that internal motives, such as the quest to gain a competitive advantage and enhance carbon performance, enable firms to adopt CMA (Hart S. L., 1995; Hart & Dowell, 2011). Furthermore, institutional theory proposes that pressure is the prime driver of CMA practices (Dimaggio & Powell, 1983; Scott, 1995; Oliver, 1991). Additionally, Stakeholder theory suggests that posit that firms will either proactively adopt CMA to align their business strategies with stakeholder interests or pressure from salient stakeholders will compel firms to undertake CMA (Mitchell, Agle, & Wood, 1997). In consonance with these theoretical propositions, this study finds that pressure from stakeholders (global pressure, national pressure, and pressure from financial institutions), financial drivers (reduction in operational cost, technological cost), and the desire to gain a competitive advantage motivate firms to practice CMA. This result is consistent with that of other studies (Qian, Burritt, & Monroe, 2018; Nartey, 2018; Burritt, Schaltegger, & Zvezdov, 2011; Bui & Fowler, 2019). The subsections below elucidate this argument further.

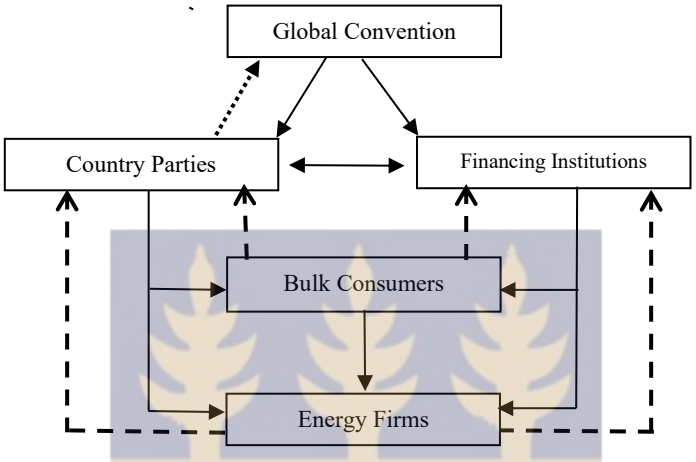
4.4.1.1 Pressure from Stakeholders

The findings relating to stakeholders' pressure are presented in Figure 4.1, which shows the hierarchy of pressure on power-generating companies. It indicates that at the apex are global bodies such as the United Nations Framework Convention on Climate Change (UNFCCC), which oversees international climate agreements (i.e. Paris Agreement) and encourages countries that are parties to the agreement to submit their Nationally Determined Contributions. Financial institutions make green investments a condition for financing energy projects. Through financing agreements, they either directly require energy firms to opt for green

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projects or indirectly demand bulk power consumers purchase energy from renewable sources. Countries that are party to international climate agreements make rules that limit the carbon emissions of bulk energy consumers and power generators.

Figure 4.1 Framework on Hierarchy of Institutional Pressure on Energy Firms



Institutional pressure

Nationally determined contribution

Carbon footprint report

Note. Author's own analysis (2025)

The details of these findings, as supported by the assertions of the interviewees, are discussed as follows:

Global Pressure: The study found that global pressure (normative and mimetic) compelled the sampled firms to adopt CMA. This pressure manifests itself through national ratification of international agreements such as the Paris Agreement in 2016 and the Kyoto Protocol in 1997. Although the ratification of these international treaties is voluntary, governments are, after ratifying them, compelled to regularly report on their nationally determined contributions (UNFCCC, 2016). They therefore put in place mechanisms to force their subjects to adhere to their commitment and report accordingly. For example, Ghana ratified the Paris Agreement in

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September 2016, and the country has since then been committed to reporting on its nationally determined contributions (EPA, 2022). Consequently, various interventions were made to compel stakeholders in the country to contribute towards the country's pledge as contained in its nationally determined contribution. This is exemplified in a statement of a participant of Company A on how international pressure influences CMA in their firm:

> *Ghana has already subscribed to the UNFCCC reporting, and that comes with some issues and Company A, as a government agency, is mandated to provide that information for the EPA to be able to report" [Interviewee 1].*

This statement also reveals that, in addition to the pressure, being a 'government agency' also induces a firm to comply with existing policies.

Pressure from bulk energy consumers: In the power generation industry, the international pressure is not only on the generating company but also on its clients consuming bulk energy. These clients are required to purchase energy from clean sources to be eligible for various incentives. Consequently, they pressurise power-generating firms to include and continuously increase generation from renewable sources. This is captured in a statement from another participant in Company A:

> *"Some of the companies that we provide electricity for, especially in the mine areas, because they also subscribe to the international community, when you are using renewable source, there's something [legitimacy and financial benefit] in there for them. ... we have a proposal from one or two of the mining companies to prefinance some of our solar projects" [Interviewee No. 3].*

National Pressure: At the national level, governments developed policies and enacted laws (Prajogo, Murwaningsari, & Mayangsari, 2023; Krueger, Sautner, & Starks, 2020) as part of

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the carbon management practices. Laws exert coercive pressure on institutions. In Ghana, there is a plethora of laws vis-à-vis the protection of the environment. Some of them border on air pollution (e.g. Environmental Protection Agency Act, 1994), hazardous chemical (e.g. Hazardous and Electronic Waste Control and Management Act, 2016), solid waste management (e.g. Environmental Assessment Regulations 1999), flora and fauna (e.g. Forest Plantation Development Act, 2000 and Control and Prevention of Bush Fires Act, 1990), energy and mineral resources (e.g. Atomic Energy Commission Act, 2000), coastal and marine environment (e.g. Fisheries Act, 2002) (Ghana Statistical Service, 2020). The regulatory institutions created by the enactments have a presence at the central and local government levels. At the level of the central government, more precisely in Accra, the headquarters of the institutions are based. At the local government level, they have branches situated in most of the 261 Metropolitan, Municipal, and District Assemblies (MMDAs). It is the branches that have direct contact with firms and ensure the enforcement of the provisions in the laws. The study indicates that CMA is motivated by regulatory requirements from the preliminary stage of investments in energy generation projects to the project's implementation stage. This assertion is supported by the following comments:

> *In terms of reducing greenhouse gas emissions, I think, right from the beginning, it's part of the process. We need to acquire a permit. It is required that we conduct an impact assessment of whatever the project is. We are supposed to indicate the sort of emissions that will be involved in our activities, and so even the regulatory body itself already has some guidelines that we must comply with [Interviewee No. 8].*

> *We are compelled by the national environmental regulations. The requirements for companies to operate in that line, as far as the climate change issues are concerned. ... Environmental Protection Agency has requirements that companies are expected to*

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follow and processes they are supposed to undertake to ensure that their operations do not unduly impact the environment [Interviewee No. 3].

Pressure from Financing Institutions: In line with the literature (Nartey, 2018; Sitompul, Suroso, Sumarwan, & Zulbainarni, 2023; Mata, Fialho, & Eugenio, 2018; Tang & Luo, 2014), this study found that pressure from financial institutions also accounts for the reason why our sampled cases practice CMA. This pressure occurs from two angles. The first one is direct pressure on energy-generating firms from existing and prospective investors, whilst the second angle is indirect pressure through bulk consumers of electricity. Financing institutions make GHG emission reduction a precondition to the provision of credit facilities to power generators and their client consuming bulk electricity (IFC, 2012). This is reflected in the following assertions:

Now, nobody wants to invest in a plant or a thermal plant which produces or releases more gases into the environment because of the greenhouse effect [Interviewee No. 6].

By virtue of the financing some of them [bulk energy consumers] have been able to secure, their lenders or their investors require them to take energy comprising of certain renewable energy mix. So, for that reason, carbon accounting is very key ... for them. So, we have to increase our generation, especially from solar, because some of their policy are not just about the emissions from the thermal power plants, but actually having a specific power plant that is renewable [Interviewee No. 10].

The situation poses coercive pressure on the generating companies. The energy firms are coerced to generate from renewable sources for new projects and shift to less carbon-intensive fuel options or risk losing financial assistance.

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4.4.1.2 Financial Drivers

Apart from making GHG emission reduction a prerequisite to the provision of financial facilities, literature also supports the statement that operational cost minimisation and the quest to benefit from opportunities (Bui & Fowler, 2019; UNFCCC, 2016) embedded in effective carbon management drives the adoption of CMA among companies. According to Bui & Fowler, (2019) "the electricity sector is carbon-intensive and potentially has significant carbon costs." The following paragraphs delve deeper into the financial drivers.

Operational Cost: It was evident from the study that the desire to minimise operational cost significantly drove the adoption of CMA in the sampled firms. Precisely, both companies sought cheaper fuel for running their plant and compared the cost of the three types of fuel (gas, light crude oil (LCO), and diesel) being used. This comparison enabled them to prefer gas over the rest. Below are some claims from Interviewee No. 7 from Company A and Interviewee No. 8 from Company B confirming this finding.

> *Generally, gas is cheaper than most of the liquid fuels. So even from a cost perspective, you are better off if you run on gas than … on liquid fuel [Interviewee No. 7].*

> *Initially, we were running on liquid fuel. We have to convert our unit to be able to run on gas. Running on liquid fuel and then running on gas, there is a significant difference [Interviewee No. 8].*

Also, it was evident from the studies that the choice of fuel also impacts other operational costs like maintenance costs.

> *The reason why it's [maintenance cost] lower is because of the time duration. If for instance, light crude oil, it will take 4000 hours to change a component, with the gas,*

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> *... it may take 8000 hours or 10,000 hours. So, it means that you are saving a lot based on the type of fuel [Interviewee No. 1 in Focus Group Discussion 1].*

Technological Cost: Another cost (both financial and ecological) that the two companies closely monitored as part of their CMA practices is associated with available technologies for thermal plant operation. That is the cost of using a single-cycle plant against that of utilising a combined-cycle plant to generate electricity. With the single-cycle operation, the high-temperature exhaust from fuel (LCO or natural gas) combustion is discharged into the atmosphere. However, in the combined cycle operation, this heat is recovered from the exhaust and used to produce steam before it is discharged into the environment at a lower temperature. The steam is used in a steam turbine to generate additional electricity. This viewpoint is reflected in the focus group discussion with some members of the finance team of Company A.

> *The same amount of LCO or gas that you need to burn to generate a certain amount of energy, if you have the steam [steam turbine], you get more, so the operational cost is less. It also influences our pricing. So, if you are generating using a single cycle, you end up spending more. So, [with] the combined cycle, [the worry] is the initial investment that we need money to do. But once you do it, you can recover through saving [Interviewee No. 3 in Focus Group Discussion 2].*

The results relating to the operational cost and technological cost are akin to those of Cadez and Guilding (2017) who found that changes in fuel (from lignite to gas or biomass) and technology (investment in fuel-efficient boilers) enabled a reduction in their carbon emissions and an increase in sales.

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Competitive Advantage: The notion of cost leadership competitive advantage is ingrained in the above statements from the focus group discussion. Using gas as a cheaper fuel and investing in steam turbines to generate more electricity at a cheaper cost influence the price of electricity. It is worth noting that Ghana supplies electricity to clients in a regulated market (low energy consumers), a deregulated market (bulk consumers), and regional parties (Cote d'Ivoire, Benin, Togo, and Burkina Faso). In a regulated market, low electricity consumers are protected by the Public Utility Regulatory Commission through a tariff regulation system. The deregulated market and the regional market offer a good opportunity for cost leadership competitive advantage to electricity producers. Consumers in these markets are at liberty to choose among suppliers, and the price of electricity is one of the factors that influences their choice. Power suppliers that can offer sustained value in the form of lower prices will have the upper hand over the rest. The existence of competition is confirmed by interviewee No. 4 as follows:

> *Now there are a lot of IPPs [independent power producers] coming into the system, and there's competition. The monopoly that my organisation [Company A] had is no more. ... We have a few broad customers who can decide where they want to buy from [Interviewee No. 4].*

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4.4.2 Carbon-Related Risks and Opportunities

According to stakeholder theory, the operation of an organisation affects different stakeholders that reciprocally affect the organisation. Also drawing from institutional theory, stakeholders exert pressures on organisations. These pressures expose the organisations to various risks and present them with opportunities. The responses to the interview highlight the risks and opportunities inherent in power generation. This section explains them in detail, commencing with the risks, followed by the opportunities.

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Carbon Related Risks

The study reveals that both companies faced investment apathy in thermal projects. Additionally, the possibility of sanctions for non-compliance with regulations and the looming redundancy of staff were issues the cases had to contend with. Besides, severe weather conditions further exposed Company A to the physical risk of damage to valuable assets. The following assertions provide further details:

Investment apathy in thermal project: Global pressure manifesting itself at national levels and the level of international financing institutions (Bui & Fowler, 2019; UNFCCC, 2016) is discourages investments in thermal projects. The study confirmed that although there is funding available for investment in energy production, there is a reluctance to invest in thermal projects. This finding is accentuated by the responses of the interviewees, exemplified below.

> *If you are an organisation that is dependent on fossil fuels for all operations, now the world is changing. You are not getting investors because they want to invest in more environmentally friendly or renewable energy production [Interviewee No. 6].*

> *We had a project recently, and there was this … development agency that provided the funds. We had challenges in the course of the project in terms of additional funds. They said they had exhausted their budget. However, we were able to raise additional funding to complete the project. They came back with the proposal that they were available to support us if we had a renewable project. So, right then, we knew they had lost interest in the traditional thermal plant [Interviewee No. 1 in Focus Group Discussion 2].*

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Krueger, *et al*. (2020) posit that institutional investors reduce their carbon footprint by engaging with firms in their portfolio to act in that direction or by divesting fossil fuel companies. However, it is more probable for the first option to be used rather than the second one because divestment comes at the cost of reduced portfolio diversification, higher transaction costs, and increased compliance costs. This study also indicates that although investors recognise the need to reduce their carbon footprint, they do not divest for fear of losing their investment. The firms adopt various carbon emission reduction strategies to minimise their carbon footprint. This assertion is supported by the response below.

> *There are stranded assets into which investments have taken place, but the breakeven period has not yet been attained, and the return on investments drastically goes down. It is appropriate that the lifespan of what is already existing, be it hydro, be it thermal, is protected and expanded if possible. The attempt to reduce emissions by converting single-cycle plants to combined cycle is something that goes in line with the call for green energy, although this process is not completely green [Interviewee No. 4 in Focus Group Discussion 2].*

Regulatory risk: It is evident from the study that both firms were concerned about the possibility of sanctions by regulators for non-compliance with carbon emission thresholds and other regulatory requirements. Tang & Luo (2014) state that of all the climate change related risk and opportunities, regulatory risk appears to be the most significant. From the salience criteria that facilitate the prioritisation of stakeholders, power is a key determinant of which stakeholder firms should be mindful. The government possesses the power to sanction defiant organisations. In Ghana, the EPA is mandated to ensure that entities operate in an ecologically sustainable manner, and the agency is empowered by the EPA Act 490, 1994, to sanction

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companies that breach the standard. The sanctions can vary from fines to license revocation. As can be seen in the claim below, the interviewee admits the finding.

> *There's going to be a whole lot of environmental restrictions and compliance that are actually going to be on you because you are running on diesel, or you are running on crude oil. Once the Environmental Protection Agency sets the threshold for emissions, if you go beyond it, it means that they have to revoke your licence [Interviewee No. 6].*

***Looming redundancy of staff*:** the study reveals that staff redundancy is a looming danger if firms completely shift toward renewable sources of energy generation. This is because, unlike thermal plants that require many staff with different expertise, renewable plants require relatively fewer staff with a small variation in expertise. Unlike solar plants, thermal plants are more complex machines. For example, the primary components of a thermal plant are boilers, turbines, condensers, pumps, generators, and transformers. On the other hand, the basic components needed by a solar power plant are photovoltaic panels, inverters, and transformers. In terms of maintenance, thermal power plants require a more rigorous process than solar power plants. By implication, there is the risk of staff redundancy should there be a complete shift from thermal to renewable as a means of power generation. From the stakeholder theory, organisations should prioritise this risk because of the salient criteria of an existing contract between employees and the organisations (Horisch, Schaltegger, & Freeman, 2020). The fear of redundancy is highlighted by a chemist whose job included a certification of liquid fuel, which was hitherto being used by Company A.

> *With liquid fuel, there are a lot of analyses that need to be done. At the end of the day, your work as a chemist is being taken away. ... once we are changing to a more environmentally friendly [power plant]. They do not require your expertise" [Interviewee No. 6].*

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Physical risk: The study showed that Company A was exposed to physical risk (Elsayih, Datt, Tang, Hamid, & Varua, 2023) which manifests itself in the form of harsh weather conditions threatening assets' integrity and causing interruptions in power supply from its hydro plant**.** Changes in weather patterns due to climate change rendered it difficult to accurately predict water supply to the dam, resulting in uncertainty in estimating electricity supply from hydro generation stations. Over the years, draught and excessive rainfall have been experienced, resulting in dire consequences on Company A's ability to generate power. Based on the salient criteria of vulnerability, the organisation must prioritise this risk since failure to supply power affects the livelihood of many vulnerable people who rely on it to ply their trade. The quote below appropriately captures the risk of a low water supply due to drought.

> *If there is less rain as we experienced sometimes back the ... dam will have less water and therefore your ability to generate electricity will be reduced [Interviewee No. 11].*

On the other hand, heavy rainfall in 2023 filled the dam to the extent that an unprecedented spillage took place to save it from complete damage. According to Interviewee No. 4 of the second focus group discussion, *"In an attempt to save the life of the dam, we have to do spillage"*. This affected about 26,000 people as of 13th October 2023 and constituted the highest magnitude of water volume spilt and the largest displacement of people in the entire history of the dam (Oppong-Ansah, 2023). Undoubtedly, the salient criterion of proximity justifies why power generators should give precedence to stakeholders close to their operational areas.

Physical risk poses a serious threat to power generation from renewable sources because of their direct susceptibility to adverse weather conditions. The slightest change in weather patterns engenders a nationwide shortage in electricity supply, leading to reduced productivity.

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Carbon Related Opportunities

The study also unveiled carbon-related opportunities like carbon trading, investment in renewable energy projects, training, and the development of the staff of the two companies. These opportunities provide avenues for dealing with the risks, and if organisations take advantage of them, they will benefit from legitimacy. The latter is another salient criterion for stakeholder prioritisation as argued by Horisch, Schaltegger, & Freeman (2020). The ensuing paragraph deliberates further on these opportunities.

Investment in eco-friendly projects: The study found that the need to mitigate carbon emissions and, for that matter, climate change, has created investment opportunities in eco-friendly projects. These investment opportunities are in the form of grants and debt facilities from development partners and bulk consumers of power. This opportunity provides an alternative to the risk of investment apathy in thermal plants.

Company B benefited from a loan facility, under the Clean Development Mechanism (CDM), that enabled the conversion of its single-cycle plant to a combined cycle. The project involved the addition of two heat recovery steam generators to utilise all the exhaust gases from a gas turbine to generate additional power. Also, one steam turbine generator and a condenser were added to the existing facility. This upgrade enhanced electricity generation from 220 MW to 330 MW.

Company A equally attracted investments into renewable power plants. Bulk consumers showed interest in green projects and were willing to secure power from designated green power sources. Citing an investment opportunity from a bulk power consumer of Company A, an interviewee responded that:

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> *Some of the companies that we provide electricity to, especially in the mining areas, have also subscribed to the international community. When you are using renewable sources, there's something in it for them. So, we have a proposal from one or two of the mining companies to prefinance some of our solar projects [Interviewee No. 3].*

It is also worth noting that the support of development partners in financing renewable energy projects in Company A was touted by respondents. This is shown in the example below.

> *It will interest you to know that most of the projects [solar power plants] that we have done over the years have all been through grant funding from KFW. In terms of commercial lending, we haven't been able to get to that point, but the issue is more on being able to meet the eligibility requirement of investors rather than the challenge of funding not being available [Interviewee No. 10].*

Ghana has the enabling environment for generating from renewable sources (solar and wind) because of the abundance of solar irradiation, which is estimated at 5.1 KWh/m^2 per day, with higher figures in the northern part of the country. The average monthly wind speed at an altitude of 60 metres in the coastal areas of Ghana was also assessed to be 5 metres per second in 2013 (Energy Commission, 2024). It is therefore not astonishing that interviewees admitted the exploration of wind projects at the coast in addition to existing solar plants in the north of the country. This is narrated by an interviewee as follows:

> *We are also at the feasibility stage as far as wind energy is concerned. We have two sites, one at Keta and one at Anlonga in the Volta region. Currently, we are at an advanced stage for a floating solar [Interviewee no. 3].*

It was evident that although investment opportunities in renewable projects are available, Company A was unable to access debt finance due to the difficulty in meeting financing requirements. This finding indicates a drawback in Ghana's policy of sourcing funding to

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finance its energy transition framework. According to the National Energy Transition Framework, the government will seek funding from "domestic banks, specialised debt and hedge funds, development banks, investment banks, pension funds and multilateral development banks" to finance the total estimated cost of the transition, which stood at US$562 billion (Ministry of Energy, 2022). This challenge is attributable to the poor macroeconomic conditions in Ghana, which were characterised by depleted foreign reserves, high inflation, and GDP contraction. It is therefore not surprising that the country sought an IMF bailout in 2023. Studies have shown that economic crises, debt overhang (particularly foreign debt), worries about government solvency, inability to borrow in the international bond markets, and fragile financial systems are some reasons why countries seek a bailout from the IMF (Dogaru, 2014; Keane, 2015; Obstfeld, 2014; Mota, Costa Fernandes, & Nicolescu, 2015; Gros, 2013; Eichengreen & Ilzetzki, 2016).

***Training and development opportunities*:** It is found in the study that numerous training and development opportunities become available to staff in the two cases due to the shift towards ecologically friendly power generation. These opportunities make room for the firms to mitigate the risk of staff redundancy. For both Companies, the opportunities involve skills development of staff in environmental sustainability. This includes training on carbon accounting (for both firms), renewable power plants, and nuclear power (for staff of company A alone). Knowledge transfer took the form of classroom learning (for the acquisition of additional post-graduate qualification), participation in workshops, seminars, and conferences like the Conference of the Parties, and practical training with the guidance of experts from the EPA, Energy Commission, Forestry Commission, and the United Nations. The elaborations of the following interviewees elucidate this opportunity further.

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They trained us in 2016. We had a training, and since then, we've been having a series of engagements. We've attended seminars … we have built our capacity over the years, and then hands-on training, doing the report ourselves. When we do the report, it's reviewed by external parties, and then their revision helps us to improve our carbon reporting and management. [Interviewee No. 2].

Some of our guys have been sent out to be trained in nuclear power generation, so they are on the ground trying to do the preparatory works, working on documentation, policies, and all that has to be put in place before we set the ball rolling in that direction [Interviewee No. 4].

Carbon trading: There is an opportunity for carbon trading available to the companies because of the efforts being made to reduce emissions. Out of the four main carbon trading markets in existence at the time of this research, only the Clean Development Mechanism (CDM) is accessible to both companies by their location in a non-industrialised nation (Ghana). CDM has the objective of minimising the global cost of GHG mitigation by making carbon trading possible between countries with legally binding carbon emissions targets and those without such legally binding targets. Through this arrangement, carbon credits can be bought by industrialised nations from projects in non-industrialised countries. Other markets that permit trading among industrialised economies are the Voluntary Carbon Market, Joint Implementation Market, and Emission Trading Market (African Carbon Assets Development, 2012). This opportunity has been identified in Company A as follows:

We are also into tree planting to serve as carbon sinks. So, we are looking at going to the international carbon credits trading system to see how best we can trade that off [Interviewee No. 4].

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> *We are developing quite a number of renewable energy projects, and the benefit of carbon trading is something that has come up very keenly. Who should take the benefit? The off-taker or [Company A]? … We at [Company A] are saying that we will have to take it, but it's a policy that will have to be spelt out [Interviewee No. 10].*

It is explicit from the above that no benefit has been derived from this opportunity as of the time of this study. There were steps being taken to develop policies and all other things required to enable the company to take advantage of this opportunity.

4.4.3 Carbon management strategies

According to institutional theory, firms faced with institutional pressure are not powerless. They respond by either acquiescing, compromising, avoiding, defying, or manipulating (Bui & Fowler, 2019; Oliver, 1991). This section argues that the cases responded by complying with institutional pressures. First, the government has a strict regulatory framework in place that compels power generators to adhere to before the issuance of licenses. Secondly, once power-generating companies become operational, there is regular monitoring by the EPA to ensure compliance. A violation of the regulations comes with severe sanctions. Thirdly, the cases comprise companies that have at least 10% government control. Company A is fully owned by the Government of Ghana, and it has its CEO and board members appointed by the government. Consequently, it is plausible for them to follow national policy. This is confirmed by Interviewee No. 10, who stated that "*complying with the national energy policy is also something key*". The government also has 10% ownership in Company B.

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Aside from that, Company B had a loan facility that imposed a more stringent environmental sustainability standard than what prevailed in Ghana at the time of this study. This was elaborated by Interviewee No. 1 in Focus Group Discussion 1 as follows:

> *If you look at our compliance with the EPA, for instance, with regard to NOx [*nitrogen oxide*] emissions, the requirement is 320 milligrams per cubic metre. But we are working to meet the most recent standard of IFC [International Finance Corporation], which is 125 milligrams per cubic metre. Currently, because of our emission controls, we are even doing less than half of the emission standard of IFC.*

The compliance strategy of Company B is consistent with the assertion of the institutional theory that a compliance strategy will be adopted when institutional pressure is high, and defiance will lead to mammoth economic consequences. Failure of Company B to comply could result in serious consequences for its loan agreement; therefore, it resorted to compliance.

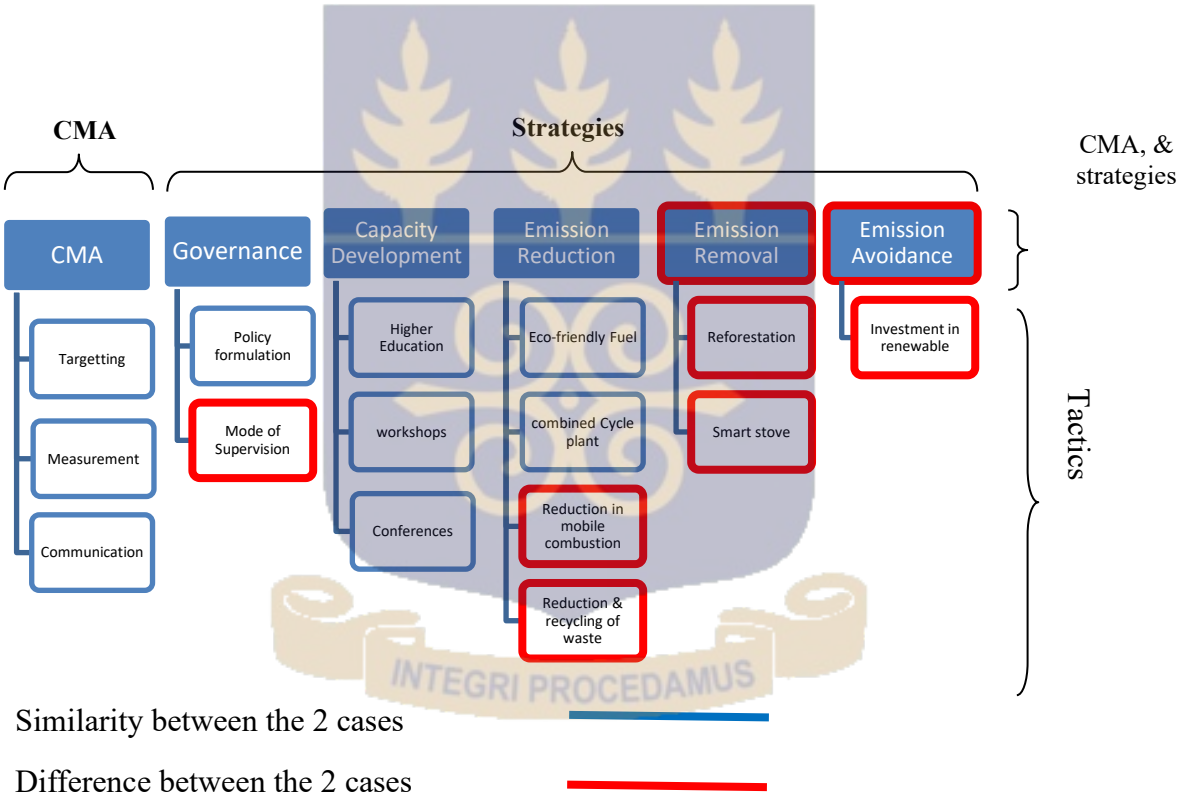
The compliance strategy of both companies, presented in Figure 4.2, encompasses governance, capacity development, emission reduction, emission removal, and emission avoidance. In consonance with the notion of isomorphism as espoused in institutional theory (Dimaggio & Powell, 1983; Scott, 1995; Oliver, 1991), the study finds a lot of resemblance in the strategies of the two companies with regard to governance, capacity development, emission reduction, emission removal, and emission avoidance. Another similarity pertains to the role of CMA in providing carbon information on the progress of these strategies for further action by management.

Contrary to the views espoused by Dimaggio & Powell (1983) that institutional pressures trap organisations into universal resemblance without the possibility to innovate and be different,

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this study finds evidence of differences in the structure and tactics between the two companies. A finding which favours the argument of Scott (1995). Key differences between the two companies pertain to the mode of supervision of strategy, reduction in mobile combustion and recycling of waste, and afforestation. Other differences include investment in renewable sources of energy and the provision of smart stoves.

Figure 4.2: Framework for compliance with climate change strategy and carbon management accounting practices of power generators



Note. Author's own analysis (2025)

The following subsections elaborate in greater detail on the acquiescence strategy of both firms and the role of CMA in supporting the strategy:

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4.4.3.1 Carbon Governance

The study found that both companies had a sustainability policy and a mode of supervising policy implementation. The policy was uploaded on each firm's website, and the interviewees were conversant with it. For example, an interviewee mentioned:

> *[Company A] has a policy, and one of the aims has been to reduce our carbon footprint, and it is not by doing only projects with renewable, but also [reducing emissions] with non-renewable projects* [Interviewee No. 7].

Company B derived its policy from the overarching policy of its parent company. Statements therein related to the company's entire portfolio of investment which included power generation and transmission, potable water production, oil and gas. At the core of this policy was the objective to decarbonise its portfolio as far as possible. On the other hand, Company A's environmental policy guided its operations within the country. The prime policy objective was to comply with national and international environmental protection regulations and mitigate the impact of its actions on the environment. These policies were copiously communicated across the rank and file of each firm, and the objective was reiterated in each firm's corporate GHG inventory report.

Mode of Supervision: supervision of environmental policy is done through the receipt and scrutiny of sustainability reports generated by CMA practices and presented to board members. Company A utilised a standing committee headed by its Environment Department to collate, monitor, and report on its carbon footprint to its board through the CEO. On the other hand, Company B relied on its existing line managers to perform the same function. This is supported by the following statement associated with Company A.

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We produce our carbon accounting reports and submit them to the EPA on an annual basis. We have a committee, but we also have a department that facilitates all that across the organisation [Company A]. That is the Environment and Sustainability Development Department [Interviewee No. 4].

With regards to company B, an interviewee responded:

Every department here is involved, from Operations to Procurement and Maintenance. The data compilation is done through an IT system. [Interviewee No. 6 in Focus Group Discussion 1].

4.4.3.2 Capacity development

The diverse opportunities for capacity development in carbon management have been profitably explored by both companies. Staff benefited from higher education and training on the best environmental practices. Apart from attending seminars and workshops, staff also had practical training with the guidance of local and international experts. This is exemplified below:

I am a carbon expert, and I have a certificate in greenhouse gas from a university in the UK. Every staff is mandated to go for training every year. [Interviewee No. 1].

4.4.3.3 Emission Reduction

Various means were devised by the cases to reduce GHG emissions. They include the use of eco-friendly fuel, the capture and use of gaseous emissions from single-cycle plants, and the minimisation of mobile combustion. Other measures encompassed the lessening and recycling of waste.

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Use of eco-friendly fuel: Thermal plants in Ghana previously ran solely on light crude oil (LCO), which is carbon-intensive. Following the discovery of offshore gas in commercial quantities and the supply of gas from Nigeria through the West African Gas Pipelines, both companies invested in gas turbines, which are cheaper and reduce the level of environmental pollution. On this subject, an interviewee responded as follows:

> *One of our carbon management practices is switching from liquid fuel to gaseous fuel. So, for now, we go strictly with natural gas, which emits less carbon in the production process. [Interviewee No. 4].*

Use of combined cycle plant: Another strategy for reducing GHG emissions was the use of combined cycle plants in both firms. It is the addition of steam turbines, condensers, and other devices to the single-cycle plant to capture the heat that would have been released into the atmosphere. The heat is used by the steam turbine to increase power generation. For example, in Company B, an investment in this technology improved electricity generation from 220 MW to 342 MW without any additional burning of gas or LCO. An interviewee stated that:

> *With a simple cycle plant, you generate your electricity, and the flue gases are discharged into the environment. But when you have a combined cycle, what happens is the flue gas goes to power a steam turbine generator for us to have some additional megawatts [Interviewee No. 4].*

Reduction of mobile combustion: Aside from the above strategies, Company A considered a reduction in mobile combustion by encouraging the use of virtual meetings and conferences through Zoom or Microsoft Teams. Face-to-face meetings or conferences were avoided as far as possible. Where it was inevitable for it to occur, carpooling was used to reduce vehicular movement. To incentivise staff to embrace this initiative wholeheartedly, an award scheme was

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instituted to reward departments of Company A that reduced mobile combustion by the largest percentage. This strategy is summarised by the following statement:

> *We instituted the eco-friendly award that helps us know the reduction within each department. So, you could have a department where in 2010 they were probably burning, let's say, 2000 kg of fuel, but in recent times they are only burning 100 kg because they reduced their travels. They have instituted online meetings ... so they don't have to travel for meetings. For every training they have, they could choose an online option. They do green travelling, and they do carpool [Interviewee No. 13].*

Company A took the reduction in mobile combustion further by importing electric vehicles.

> *"We just brought in electric buses into the system. We just got them about two weeks or three weeks ago" [Interviewee No. 3].*

A triangulation of these assertions against the GHG emissions from the mobile combustion of Company A, as shown in Table 4.3, reveals an increase in emissions from 1,200.09 tCO_2e in 2012 to a peak of 2,991.93 tCO_2e in 2017. Thereafter, GHG emissions reduced significantly to 1,192.3 tCO_2e, the second lowest point after emissions of 737.1 tCO_2e in 2013. From 2018, Company A experienced fluctuations in vehicular GHG emissions levels, but did not reduce emissions to the level in 2012. This finding implies that the interventions of Company A did not significantly reduce absolute GHG emissions from vehicles, but they could have contributed to emission avoidance.

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Table 4.3: GHG Emissions from Vehicular and Petrol Consumption

Year	GHG Emissions (tCO_2e)		
	Diesel	Petrol	All GHGs
2012	1084.86	115.23	1200.09
2013	459.95	277.15	737.1
2014	984.87	1316.44	2301.3
2015	1774.37	549.92	2324.29
2016	1585.5	197.34	1782.84
2017	2743.56	248.37	2991.93
2018	1086.85	105.46	1192.3
2019	1322.14	129.43	1451.57
2020	1107.55	121.24	1228.79
2021	1669	159.21	1828.21
2022	1238.28	142.43	1380.72
2023	1318.04	152.73	1470.77

Source: Company A

Unlike Company A, which banked on virtual meetings, carpooling, eco-awards, and the use of electric vehicles to achieve mobile combustion reduction, the study found limited use of such strategies in Company B. This was primarily because Company B had a single plant located at one station. There was no need for virtual meetings and carpooling when physical meetings could easily be held in-house. Virtual meetings took place between Company B and its parent company.

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Reducing and recycling waste: Literature (ISSB, 2023; World Business Council for Sustainable Development and World Resources Institute, 2004) supports the assertion that waste, which is not well managed, generates methane, which is one of the GHG emissions recognised by the Kyoto Protocol. It is therefore fascinating to note that Company A made a conscious effort to reduce waste generation and to recycle paper waste.

> *For all operational areas, we instituted a system whereby all our papers, every single paper that is used, if it's no longer in use, it's shredded and then submitted to the Environment Department, where we also forward it to a toilet roll facility or a paper*

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recycling facility that recycles the paper and then gives us toilet rolls in return for that. [Interviewee No. 13].

One could infer from the above that paper waste was segregated from other types of waste to reduce the quantity of waste sent to the landfill site. It was also recycled as an ecologically friendly option. What was yet to be done relates to the separation of other waste materials. This gap was recognised by an interviewee who stated:

We are working further on not taking our plastics to the landfill site because it also traps heat and causes ... emissions of various gases into the air [Interviewee No. 13].

4.4.3.4 Emission removal

Company A showed commitment to GHG emission removal through afforestation by planting trees at various locations to serve as carbon sinks. Over 57 hectares of degraded land were reforested with cashew and forest tree seedlings in 2022. Besides, it also made efforts to minimise tree cutting in the riparian communities by providing them with smart stoves. It is explained by the interviewee below:

For the whole of Green Ghana Month, we have to plant so many trees. ... The plants have a regenerative ability, so even when cut for firewood or used for any other thing the stump will regenerate. Hence, it reduces the pressure on the natural forest. Also, we set up climate-smart stoves. These climate-smart stoves use less firewood than they initially would have used for their cooking or commercial activities. [Interviewee No. 13].

4.4.3.5 Emission avoidance

Investment in renewable energy production was one strategy adopted by company A to avoid

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carbon emissions. It is posited that renewable energy generates virtually no GHG emissions (Qi, Huang, & Sheeraz, 2023). The increase in electricity generation from renewable sources prevents GHG emissions that would have resulted from thermal. Company A invested in three solar power plants, yielding 32 MW of power at the time of this study, and was exploring a floating solar project on one of the country's dams. Also, it was equally in developing a 160MW wind power plant at two stations in the coastal areas of Ghana. This is elucidated below:

> *So far, we have four solar plants in the system. Now the investors are ready. The lenders are ready to advance money for renewable. We have also done some studies in the area of wind. Currently, we are working on a 160 megawatt wind farm. It is still at the initial stage. Very soon, we will be adding the wind to the grid [Interviewee No. 12].*

Although the interviewee mentioned four solar plants, the company's website indicated that three solar plants were in operational existence at the time of this study.

The study also shows that the reliance on renewable energy sources is highly susceptible to the weather conditions. Power supply gets interrupted due to adverse changes in weather patterns, and this necessitates additional investments in power storage to maintain a constant supply. Such investments are expensive and may increase the unit price of power. The cost factor had prevented additional investment and had therefore exposed the operation of Company A's renewable energy sources to the problem of the intermittency of renewable. Company A was exploring the possibility of investing in a wind power plant. When this objective is achieved, the combination of solar and wind could facilitate the hybridisation of generations to maximise solar energy during the day and wind energy at night. The predicament of generation using solar is highlighted in the ensuing paragraph.

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> *We don't have batteries. ... if you are adding batteries to a solar plant, it is not necessarily to store that power to be used when the sun is down. We have what we call the phases of renewable. That is because the sun doesn't stay constant throughout the period. Sometimes you have a cloud going under it, so the sun's power comes down and goes up again. These are what we call intermittency of renewable [Interviewee No. 11].*

Another hurdle exacerbating the situation above is the use of less efficient technology by Company A in solar power generation. Solar panels are either mounted on a fixed-tilt system or a tracking system. Whereas the former is immobile and faces one direction, the latter tracks the sun and moves in its direction to optimise the receipt of sunlight. It is posited that a solar plant with a tracking system produces 20 per cent more power than fixed-tilt solar power. A tracking system is, however, very expensive to acquire and maintain, and it is not suitable for undulating fields and terrains with steep slopes (PVCase, 2022). Given that the savannah area where the solar power plants of Company A are located is endowed with vast plain lands, probably, the choice of a fixed-tilt system over a tracking system was highly influenced by cost, since ecological technologies are often expensive (Cadez & Guilding, 2017). This choice, however, diminishes the yield derivable from investments in solar power plants. An interviewee retorted that:

> *The system we have here is the tilt angle plant [but] when you go to some other countries, they have the tracking system. That one ... where the sun is directed is where the panels face. When you look at their duration records with their graph for the duration, you realise that their graph is stable, and it gives a straight line [Interviewee No. 15].*

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4.4.3.6 Carbon Management Accounting Practices

In line with Kazemian *et al*. (2022), the study focused on CMA practices that entail data collection, data analysis, interpretation, and reporting. The practices are summarised into target setting, emission measurement, and communication to relevant stakeholders. It is evident from the study that Ghana ratified the Paris Agreement and is obliged to report to the UNFCCC on its nationally determined contribution. As part of its energy transition plan, the nation targets to achieve net-zero emissions in electricity generation in 2070 (Ministry of Energy, 2022). Consequently, through the EPA, the government sets and monitors national emission targets for operators in the electricity generation sector. Aside from that, there are companies that, by their sources of funding, adhere to more stringent targets set by financiers. The study shows that both firms have carbon emission targets they strove to meet. For example, an interviewee mentioned that:

> *Once the target is set, it is given to the Environment Department because they are responsible for environmental issues, and it is further cascaded down to the various departments that are supposed to implement it. So, it is well communicated across the organisation [Interviewee No. 4].*

After target setting is the measurement of GHG emissions. This practice enabled the firms to compare the data collected with the target. Emission is measured with the use of software integrated into the thermal plants of both firms for real-time monitoring and corrective responses. This is indicated in the response below:

> *We have what is called the Human Machine Interface (HMI). It acts as our automation. So, this automation software .... is where you can pull out data. You can back data as well to get those readings that you have, and this is also an interface for operation. So, if they found out that your reading of carbon is abnormal, maintenance [department]*

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checks to make sure that it is corrected [Interviewee No. 5 in Focus Group Discussion 1].

In addition to the software, Company A relied on a committee comprising representatives from its various departments and experts from other organisations to compute carbon emissions and carbon removal emanating from its climate change strategic responses. Equally accounted for by the committee is the quantum of carbon avoided through green investments.

Company B relied solely on its line managers for such computation. A probe into the difference in approach between the two firms disclosed that their level of operational complexity accounted for the variation. Company A generated power from a mix of two hydro stations, five thermal plants, and three solar plants, while Company B had only one thermal plant. Company A's operation appeared more complicated than that of Company B, and this informed their management to resort to a carbon accounting committee drawn from the relevant departments (engineering, hydro, technical service, procurement, and environment) and experts from the EPA, Forestry Commission, and Energy Commission. This 'network of relationships' (Freeman, 1984; Freeman, Harrison, Wicks, Parmar, & de Colle, 2010) among numerous departments within the same organisation and between the organisation and representatives from other firms is one of the postulations of the stakeholder theory that this finding confirms.

With regards to scope, both Company A and Company B measured Scope 1 and Scope 2 GHG emissions. Whereas Company A measured Scope 3 emissions resulting from employees' travels, Company B did not scope 3 emissions. An interviewee retorted that:

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> *The carbon emissions are measured on a plant-by-plant basis for us to have data as to what we are contributing in terms of greenhouse gas emissions, and we'll also make sure that at least we are within a certain allowable limit [Interviewee No. 5].*

Concerning the frequency of reporting, regulatory requirements obliged the two firms to report their carbon emissions and management practices to the EPA quarterly. Besides, it was an integral part of both companies' CMA practices to report monthly to their respective management on their carbon footprint and progress towards targets. This finding is consistent with that of Kazemian *et al*. (2022) who noted that, internally, CMA reports were submitted monthly to Chief Executive Officers (CEOs). Quarterly reports go to the board of directors and government agencies.

4.4.3.7 Carbon Performance of Sampled Firms

In line with Hoffmann & Busch's (2008) carbon performance indicator, the study assessed the carbon intensity of both firms. Figure 4.3 presents the carbon intensity of Company A based on electricity generation. It indicates that Company A improved its carbon intensity by 23.75% in 2023 compared to 2012. Over the period, there have been fluctuations in the year-on-year performance, with 2018 recording the best carbon intensity of 0.49. Since achieving 0.49 in 2018, Company A experienced a consistent rise to 0.52 in 2019 and 0.60 in 2020. Carbon intensity also rose marginally in 2022 and 2023 to 0.58 and 0.61, respectively.

Regarding Company B, there was a 14% reduction in its carbon intensity based on electricity generation in 2023 compared to 2019. The company equally reported a 32% reduction in carbon intensity based on revenue in 2023 compared to the baseline of 2019.

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These results illustrate that both companies were accounting for their GHG emissions and were committed to improving their carbon performance.

Figure 4.3: Carbon intensity based on electricity generation (CO2e/MWh)



Source: Company A

4.4.3.8 Discussion of Result

It is evident from the study that the quest to gain a competitive advantage and enhance carbon performance enables the two energy firms to adopt CMA practices. This result conforms with the position of the NRBV (Hart S. L., 1995; Hart & Dowell, 2011) internal motives lead firms to embark on pollution prevention, product stewardship and technological innovations to gain a competitive advantage and improve environmental performance. The result also supports the assertion of stakeholder theory that firms either voluntarily adopt CMA to align their interests with those of stakeholders or are compelled by salient stakeholders to do so. The study finds that salient stakeholders mount pressure on power generators to adopt CMA. Additionally, this result tallies with the findings of previous studies (Qian, Burritt, & Monroe, 2018; Nartey, 2018; Burritt, Schaltegger, & Zvezdov, 2011; Bui & Fowler, 2019). Other motivations that drive the adoption of CMA practices, as identified in this study, include the necessity to minimise operational cost through pollution prevention and attract investment in green projects, a finding that is akin to that of Bui & Fowler (2019).

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Regarding carbon risks, the findings show that the possibility of sanctions for non-compliance with regulations constitutes the highest risk to which both firms were exposed. This result agrees with the findings of Tang & Luo (2014) who affirm that of all the carbon-related risks, regulatory risk appears to be the most significant. The firms' concerns about the likelihood of sanctions for infringing regulatory provisions create an enabling environment for the EPA to achieve its mandate with minimal effort. It is therefore not surprising that both firms adopted the carbon management strategy of compliance.

The appetite for clean energy offered both companies the opportunity to upgrade their single-cycle plant to a combined cycle plant, from which Company B has benefited. As a result of the upgrade, Company A significantly improved its carbon performance. Company A equally had support for its renewable energy projects, invested in carbon sink projects and was seeking avenues to trade its carbon credits on the international carbon market.

The results also reveal that the two firms adopted a compliance strategy because of government, high institutional pressure, and debt financing of projects. Government ownership of Company A ensured the alignment of corporate strategy with government policy on energy transition. Moreover, the debt financing enjoyed by Company B placed an obligation on the firm to comply with the net-zero emission target. To sum it up, the study indicates that both companies adopted CMA, which supported their compliance strategy, leading to improved carbon performance.

4.5 Conclusion

NRBV, institutional theory and stakeholder theory provide complementary backing for this study. The results indicate that the desire for a competitive advantage and enhanced

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environmental performance drove the companies to adopt CMA. In addition, pressure from stakeholders compelled the firms to adopt CMA practices in their operations. This result is akin to that of Qian, *et al*. (2010) who found that social structures and organisational contextual factors influence CMA practices. From Oliver's (1991) five strategies of compliance, compromise, avoidance, defiance, and manipulation, the study found that both firms chose compliance as their primary strategy. CMA practices enabled the measurement of emissions across all strategic compliance responses of emission removal, emission avoidance, and emission reduction. However, there are differences in these responses.

In line with Qian et al (2018) who espouse that environmental uncertainty, strategic proactivity, and operational complexity are directly associated with environmental management accounting, the study found that the complexity of operations and strategic proactivity accounted for the differences in CMA practices and strategies between the two cases. Conversely, environmental uncertainty and identical institutional pressures support the similarity in CMA practices and strategic responses of the firms. Damert & Baumgartner (2018) state that, in the long run, exposure to similar institutional pressure will cause firms operating in the same sector to have similar strategic approaches. In consonance with this, both companies had well-publicised environmental sustainability policies that directed their CMA practices and strategies, but they established different structures to ensure supervision. Furthermore, both firms were driven by cost and the improvement of their carbon performance to opt for a cheaper fuel and to convert their single-cycle plant to a combined-cycle plant. Additionally, Company A strategically reduced mobile combustion and implemented extensive reforestation. Larger companies, according to Damert & Baumgartner (2018), are exposed to greater institutional pressure and are likely to possess more resources to carry out climate change-related activities.

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4.6 Policy Implications

Power generators are influenced by institutional pressure from global bodies, national governments, and financial institutions to engage in CMA. As a result, mammoth opportunities present themselves to policymakers. These ranged from luring investments into renewable energy, carbon capture, carbon sequestration technologies, and reducing emissions emanating from thermal. These investments tend to lower the cost of power, leading to a cost-competitive advantage.

It is necessary for policymakers, given the attractiveness of green energy to investors, to increase their investment in solar, wind, hydro, and nuclear energy. The climate and landscape of Ghana are conducive for solar energy generation in the northern part of the country, wind in the southern part, and hydro along the Volta River and other waterbodies. It is therefore expedient that these favourable natural conditions be exploited to maximise green energy through policy interventions. For instance, the results of this study reveal that there is more room for augmenting power generation from existing solar plants in the country by mounting the solar panels on a tracking system rather than fixed-tilt angles. It is thus relevant for policymakers to consider this switch.

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Despite the existence of numerous investment opportunities, the study indicates that so far, the country has benefited from grant funding for solar power. Commercial lending has taken place with Company B. It is necessary for policies to resolve poor economic indicators resulting in the absence of commercial loans for Company A.

Another important result of this study is that the reliance on thermal plants as part of the generation mix would persist in the foreseeable future. In other words, there is no policy

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preventing any company from generating power using thermal. It is therefore imperative for policies to target greener inputs and technology to reduce the impact of thermal power on the environment. Specifically, the replacement of light crude oil and diesel with gas as fuel on the one hand and the conversion of single-cycle plants into combined-cycle plants on the other hand should persist. Additionally, policymakers should constantly embrace new technologies that always ensure greener power and higher output.

In Ghana, the energy sector, including the transport subsector, is the most polluting sector, contributing 46.6% of GHG emissions (EPA, 2021). To tackle the menace of pollution from mobile combustion, existing policies encourage the purchase of new vehicles while discouraging the importation of used vehicles. What has not been fully explored is the gradual switch to electric and hydrogen-fuelled vehicles. This initiative requires the establishment of requisite vehicle charging points to facilitate the patronage of these vehicles. The provision of tax incentives to encourage patronage is another laudable policy in this direction.

Policymakers must develop capacity in renewable energy and environmental sustainability. As highlighted in this study, ongoing training in carbon accounting, greenhouse gas inventory computation, and nuclear energy management should be intensified. Policies should develop the skills of the youth in environmental sustainability and its related technology to enable them to take advantage of job opportunities. Finally, the study discloses carbon trading opportunities for companies operating in non-industrialised countries to benefit from the CDM market, which policymakers can take advantage of.

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4.7 Limitations and future research

While this study provides valuable insights into carbon management accounting practices, its limitations must be acknowledged alongside the methodological strategies employed to enhance trustworthiness.

The findings are based on a small sample of two cases, which limits statistical generalisability to a larger population of firms. However, this study does not aim for statistical generalisation but for analytical generalisation to theory (Yin, 2009). The two cases were purposively selected as information-rich examples of organisations with demonstrated commitment to CMA, allowing for in-depth exploration of the phenomenon. To enhance applicability in similar contexts, a description of the Ghanaian institutional setting, including regulatory frameworks, national energy policies, and international treaty obligations, is provided.

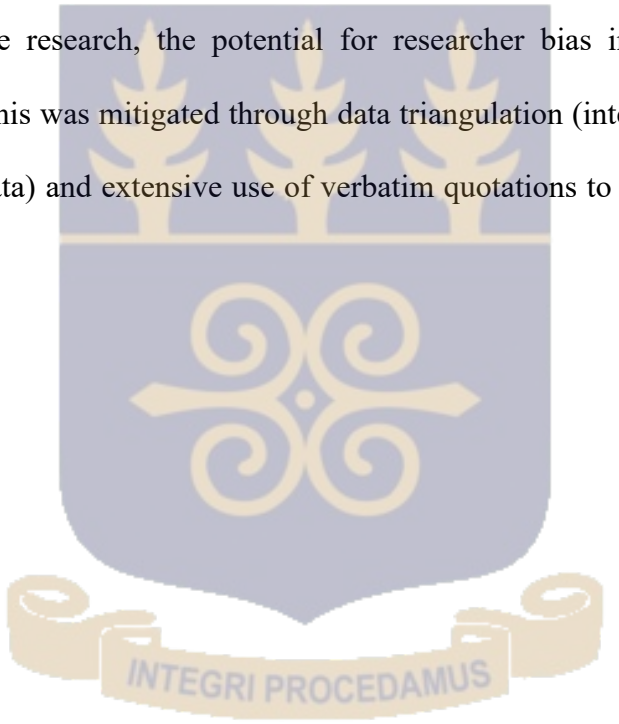
Sectoral Scope. The firms studied operate within Ghana's energy sector, and both were purposively sampled because of their established commitment to CMA. Therefore, prudence must be exercised in applying these findings to firms in other sectors or to organisations without demonstrated commitment to carbon management. Nevertheless, the theoretical propositions developed here—particularly regarding institutional pressures, strategic responses, and the role of CMA—may hold relevance for carbon-intensive sectors more broadly. Future research should consider a multi-sectoral sample comprising firms from the waste sector, industrial products and product use, and forestry and other land use, including both companies with and without published sustainability reports.

This study employs a cross-sectional design, examining two cases within a specific period. Carbon strategies are known to vary with policy changes (Bui & Fowler, 2019), and this study

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does not examine how firms adjust their strategies over time or how the motivations behind CMA practices evolve with changing climate policies. To partially address this within the cross-sectional design, data were triangulated across multiple sources, including retrospective accounts from participants, documentary analysis of policy documents, and historical emission records (see Table 4.3), to capture how past policy changes have shaped current practices. Nonetheless, a longitudinal study tracking motivation and strategic responses to changing climate policy represents an important direction for future research.

As with all qualitative research, the potential for researcher bias in data collection and interpretation exists. This was mitigated through data triangulation (interviews, focus groups, documents, archival data) and extensive use of verbatim quotations to ground interpretations in participant voices.



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CHAPTER FIVE

Summary, Conclusion and Recommendations

5.1 Introduction

This chapter summarises the thesis, focusing on key aspects of the literature that contextualise the study. It reiterates the thesis's objectives and how each one was achieved. Precisely, there is an elucidation of the sampling technique, sample size and data analysis. The chapter equally discusses the implications of the findings and the contribution of the study. It proceeds with the limitations of the study and recommendations for future studies.

5.2 Summary and conclusion

The thesis examines the introduction of Environmental Management Accounting (EMA) into functional-level environmental strategies and strategic outcomes. It comprises three papers, each of which is contained in a chapter.

The first chapter of the study provides the background of the study. It illustrates the growing incidence of environmental degradation resulting in air, water and soil pollution. The adverse effects of pollution and the existential threat it poses to humans compel the global leaders to rally all and sundry to ensure sustainable development. Firms devise and implement sustainable development strategies to enhance their environmental footprint (Liu & Zhang, 2022; Zatini, Porta, & Za, 2025). Unfortunately, few studies exist on the connection between organisational sustainability strategies and environmental performance (EP). Existing works focused unduly on corporate-level strategy (Bansal & Roth, 2000) and business unit-level strategy (Ismail, Rose, Abdullah, & Uli, 2010; Bui & Fowler, 2019), leaving functional-level strategy with explorable research opportunities. Within functional-level strategies, studies

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have been carried out on research and development (Wang, 2019; Chen, Lai, & Wen, 2006), marketing (Leonidou L. C., Leonidou, Fotiadis, & Zeriti, 2013; Leonidou, Leonidou, & Kvasova, 2010), and environmental management system (Melnyk, Sroufe, & Calantone, 2003), leaving GHRM with a research vacuum. There is also a paucity of research on how environmental management can be repositioned from a mere compliance-oriented activity into a strategy that drives sustainability and excellent performance. Moreover, scholars have called for studies on the broader scope of Environmental Management Accounting to focus more on the narrower scope of Carbon Management Accounting (CMA) because air pollution is the most devastating of all pollutants and the challenges of the lack of standardised methods for measuring emissions, disclosure and managing greenhouse gas emissions (Changalima, Rutatola, & Ntangeki, 2025; Sitompul, Suroso, Sumarwan, & Zulbainarni, 2023). Although researchers have responded to these calls, there remain research avenues for assessing the mediation role of competitive advantage (COMP) in the EMA-EP relationship. Secondly, how CMA supports functional environmental strategies to boost carbon-related EP is also underexplored. Consequently, the study specifically: (i) examined the mediating role of EMA in the relationship between GHRM and EP, (ii) ascertained the impact of EMA on competitive advantage and environmental performance, and (iii) explored how CMA drives carbon management strategies to enhance EP.

The second chapter examined the mediating role of EMA in the relationship between GHRM and EP in environmentally sensitive industries of Ghana. Following a positivist research approach, hypotheses were formulated based on the Natural Resource-Based View (NRBV) and stakeholder theory. According to NRBV, firms can achieve competitive advantage and enhanced environmental performance by deploying resources and capabilities to pollution prevention, product stewardship and sustainable development. The study argues that these

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capabilities have differential effects on EP. GHRM cultivates employee environmental behaviour, creates cross-functional green teams and instils green norms and values into an organisation's culture (Molina-Azorin, Maria, Juan, Jorge, & Eva, 2021) to maximise pollution prevention, product stewardship and sustainable development. EMA assists in measuring and monitoring the quantum and cost of waste, emissions and resource use, thereby enhancing pollution prevention strategies (Zatini, Porta, & Za, 2025; Molina-Azorin, Maria, Juan, Jorge, & Eva, 2021). Moreover, EMA tools such as In effect, EMA tools such as Material Flow Cost Accounting, Supply Chain Accounting, Lifecycle Costing, Supplier Audits, etc (Schaltegger & Burritt, 2017) can be used to identify gaps in cross-functional collaborations needed to achieve product stewardship and provide real-time feedback on progress towards sustainable development.

Stakeholder theory (Horisch, Schaltegger, & Freeman, 2020) also posits that firms in high-polluting environments will be compelled by salient stakeholders, including regulators, to prioritise GHRM to improve EP. EMA enables firms to meet stakeholder demands by quantifying environmental impacts. It also serves as a tool that translates GHRM into improved EP. Therefore, the study hypothesises that GHRM enhances EP through EMA.

The sample was obtained from the energy industry, the waste management sector, manufacturing companies, transport firms, and agriculture firms. Data was collected through a survey after which 196 firm-level responses were analysed using PLS-SEM. The results show that GHRM significantly enhances EMA, which in turn, positively and significantly influences EP. Furthermore, EMA complementarily mediates the association between GHRM and EP, suggesting that while GHRM directly enhances EP, its impact is amplified when EMA is introduced into the association. Regarding the differential impacts of the components of EMA,

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the results unveil that Physical EMA (PEMA) contributes more to the total effect of GHRM on EP than monetary EMA (MEMA). The study contributes to the literature on environmental sustainability by examining the link between GHRM and EP through EMA, with emphasis on the differential impact of the components of EMA. It illustrates that of the two components of EMA, PEMA is more influential in mediating the relationship between GHRM and EP.

Chapter Three ascertains whether EMA can be repositioned from a mere technical tool to an environmental capability, in line with the NRBV. A quantitative research approach was followed, relying on NRBV to formulate the hypothesis (Hart S. L., 1995). The theory espouses that a firm can achieve COMP and EP through capabilities aligned with pollution prevention, product stewardship (Hart S. L., 1995), and clean technology (Hart & Dowell, 2011). In preventing pollution, firms that significantly reduce wastes, emissions from source and avoid the cost of non-compliance with environmental regulations vis-à-vis those of their rivals while maintaining the same quality of service or product are likely to benefit from a cost-competitive advantage (Porter & van der Linde, 1995).

Product stewardship enables organisations to achieve eco-design, attain product or service differentiation as a source of competitive advantage, and target environmentally conscious clients at a premium price (Hart & Dowell, 2011; Hart S. L., 1995), while achieving higher EP. Finally, clean technology minimises pollution and creates first-mover advantages in emerging green markets (Hart & Dowell, 2011). EMA facilitates the measurement and monitoring of the cost, waste, emissions and resource use, allowing managers to reduce inefficiency, achieve COMP and enhance EP (Zatini, Porta, & Za, 2025; Molina-Azorin, Maria, Juan, Jorge, & Eva, 2021). Consequently, the study hypothesises that EMA improves EP through COMP.

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Survey data were collected from manufacturing firms in six cities in Ghana. Using PLS-SEM, the analysis was based on 85 firm-level responses emanating from 231 senior management staff. The results indicate that only PEMA leads to COMP. MEMA has no such effect on COMP. Additionally, the study underscores the positive influence of EMA on EP, but it shows that COMP has no mediating role in the association between EMA and EP. In terms of contribution, this chapter contributes to the literature by showing that EMA adoption leads to direct improvement in EP, even in the absence of COMP. It highlights the importance of balancing environmental investments with cost efficiency, as excessive spending on EMA may not yield competitive returns.

Chapter Four explored how CMA drives carbon management strategies to enhance EP. An exploratory case study method was used to analyse 15 interviews involving 24 senior management personnel of two power-generating companies. The result asserts that three key factors motivated CMA practices. These are pressure, cost reduction, and desire for cost-competitive advantage. Moreover, the firms face carbon-related risks, the most significant of which is the threat of sanctions due to non-compliance with regulatory requirements. They equally benefit from investment opportunities in clean energy. The study reveals that both firms followed the carbon strategy of acquiescence as espoused by Oliver (1991). In adopting this strategy, the two companies engaged in emission reduction, emission removal, and emission avoidance and board supervision. CMA practices serve as the information nerve that drives the implementation of the compliance strategy, leading to enhanced performance. The study contributes to the literature on carbon accounting by highlighting how CMA practices interrelate with environmental strategies to improve carbon performance.

The three integrated studies systematically build upon each other to examine EMA and its role in enhancing EP. Their integration is evident across thematic, theoretical and methodological

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dimensions. Thematically, all three studies focus centrally on EMA and EP. The first establishes EMA as a mediator between GHRM and EP, showing how the cohesive practice of GHRM and EMA achieves a more than proportionate enhancement in EP than practising only GHRM. The second extends this by testing whether EMA is a strategic environmental capability in line with NRBV. It establishes that of the two components of EMA, physical EMA is an environmental capability. The third study explores how CMA, as a specialised type of EMA, relates to carbon strategies to drive carbon performance. It illustrates qualitatively, beyond the quantitative causal links, how a specific form of EMA operates practically to achieve an improvement in EP. This mixed-methods approach offers both breadth and depth.

Theoretically**, the** three studies employ complementary frameworks. The first and second papers draw on the NRBV and Stakeholder Theory to explain the reasons for EMA adoption, differential effects of EMA components and the mediated pathways. The third adds Institutional Theory, providing a basis for comparing the two cases in the sample.

Cumulatively, the studies confirm that GHRM enhances EP through MEMA and PEMA, with PEMA being more critical. Besides, PEMA is a strategic environmental capability far beyond a mere operational cost for compliance. Finally, the results indicate that immense institutional pressures are driving CMA adoption and that this adoption shapes an enhancement in carbon performance.

5.3 Implications of findings

The findings of the thesis have implications for theory, practice and policy. To begin with, the research finds a positive and significant influence of GHRM on EP through EMA, implying that organisations must promote GHRM by recruiting and selecting, training, developing and

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motivating ecologically committed staff. The government must also promote EMA practices in organisations by making EMA practices a condition for granting or renewing the operating licenses of high-polluting firms. To promote PEMA government should include EMA in school syllabi or the syllabus of professional studies, like the Institute of Chartered Accountants. Moreover, governments must reinforce and enforce regulations in line with new developments affecting the ecology and require firms to report on the continuous professional development of their staff.

In addition, in deploying GHRM strategies to enhance EP via EMA, the findings indicate that PEMA has a greater mediating role than MEMA. Theoretically, this illustrates the existence of a differential effect in the mediating role of EMA in the GHRM–EP relationship. Practically, companies should prioritise the acquisition and deployment of PEMA tools such as Material Flow Cost Accounting and Life Cycle Assessment to identify material usage inefficiencies and cut costs. This prioritisation is critical amid resource scarcity and the need for efficiency. For corporate policy, prioritisation of PEMA over MEMA requires more emphasis on skills development in the area of PEMA and the acquisition of technologies that aid in tracking material usage and residues, assessing the ecological impact of products or services, and identifying ways to reduce adverse environmental impacts.

Furthermore, the findings indicate that although PEMA positively impacts COMP, its benefit in terms of enhancing EP is not through COMP. This underscores the need for firms not to rely on competitive advantages to achieve superior environmental outcomes. This insight calls for a strategic balance between environmental targets and the cost of achieving them. Businesses should aim to achieve ecological benefits while remaining mindful of costs, as excessive spending on EMA may not provide a competitive edge.

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Regarding GHG emissions, the findings elucidate the investment appetite of green energy sources such as solar, wind, hydro and nuclear power. Ghana has a conducive landscape for solar energy generation in the north, wind in the south and hydro along the Volta River and other water bodies. It is therefore important for investors to take advantage of these opportunities and for the government to create an enabling environment for private-sector funding of green energy projects. Additionally, the study discloses that currently, existing solar plants in the country are mounted on fixed-tilt angles, limiting the generating capacity of solar plants. Policymakers could maximise energy output by considering mounting them on the tracking system.

The results further highlight that thermal plants would continue to be part of the energy generation mix of Ghana for the foreseeable future. Therefore, policies should encourage greener inputs and technology to reduce the adverse impact of thermal power on the environment. To achieve this goal, corporations and the government need to extensively develop capacity in CMA. Other policy interventions, like the replacement of light crude oil or diesel as generation fuels with gas, conversion of single-cycle plants into combined-cycle plants, and the continuous innovation and investment in green technologies, should be encouraged.

Apart from the above, the thesis also reveals that the transport subsector, being part of mobile combustion, contributes significantly to GHG emissions. Consequently, policies should be geared toward the purchase of new vehicles, the discouragement of the importation of used vehicles and a progressive switch to electric and hydrogen-fuelled vehicles. Complementary investment should be made into the establishment of vehicle charging points to increase the

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patronage of greener vehicles. The provision of tax incentives to encourage patronage is another laudable policy in this direction.

Finally, an important policy recommendation that addresses the risk of redundancy indicated in the study is capacity development in renewable energy and environmental sustainability. More capacity is needed in carbon accounting, greenhouse gas inventory computation, nuclear energy management, renewable energy development, etc. Also, given the opportunity of carbon trading for companies operating in non-industrialised countries, expertise should be developed to enable the companies to take advantage of carbon trading.

5.4 Contributions

The thesis makes contributions to the literature on the role of EMA in promoting functional-level strategies and strategic outcomes. The examination of functional level strategies is a departure from existing literature that focuses on corporate strategies concerned with high-level plans about which businesses or product lines to compete in and how to distribute resources to attain this overarching goal. Unlike previous studies, this thesis contributes to the literature by focusing on how strategies in specific departments (i.e., HR, accounting, and sustainability) interrelate and impact strategic outcomes, such as COMP and EP. Following this novelty, the study contributes to theory by demonstrating that PEMA has a stronger differential effect than MEMA in translating GHRM into EP. Although previous studies have distinguished between PEMA and MEMA as two components of EMA, there was no focus on their unequal mediating role between GHRM and EP.

Furthermore, the thesis highlights that although PEMA and MEMA are components of EMA, they unequally impact COMP. Whereas PEMA's impact is significant, MEMA has no

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significant impact on COMP. The study, however, confirms existing knowledge that PEMA and EMA enhanced EP.

Finally, in line with the principle of focusing on micro instead of macro concepts, the study isolates CMA from the broader EMA constructs and explores its drivers and impacts on carbon strategies and performance. In support of existing knowledge, the thesis confirms that pressure, cost-reduction and desire for competitive advantage motivated CMA adoption. It equally illustrates that debt finance and government ownership shape CMA adoption, compliance strategies, and carbon performance, an underexplored area in sustainability accounting research.

5.5 Limitations of the thesis

Despite the significant contributions of this work, it has some limitations that ought to be highlighted. First, the data collected for analysis of the papers in Chapters Two and Three are not normally distributed. This resulted in the choice of variant-based Partial Least Squares Structural Equation Model (PLS-SEM) for the analysis. Hair, Risher, Sarstedt, & Ringle (2019), caution scholars about the applicability of goodness of fit indices, like R^2, f^2 and Q^2, in PLS-SEM because they were still being developed. This study dealt with the limitation by computing the Standardised Root Mean Square Residual (SRMR), which detects model misspecification by measuring the discrepancy between observed correlations and model-implied correlations (Hair J. F., Hult, Ringle, & Sarstedt, 2022).

In addition, the study on CMA practices in Chapter Four is cross-sectional research, which does not indicate how the firms' carbon strategies change over time in response to changing carbon policies. Although the analysis discusses the carbon performance of the firms from 2012

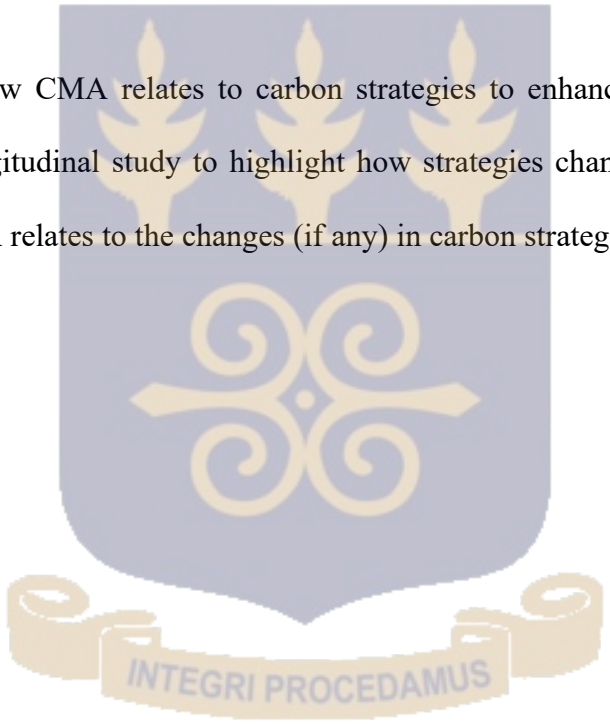
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to 2023 for Company A and from 2019 to 2023 for Company B, this analysis is centred on only one theme, leaving the rest.

5.6 Future studies

It is recommended that future studies on the association between GHRM and EP through EMA and those on the relationship between EMA and EP through COMP should use a covariant-based structural equation model because of its well-tested and universally accepted model fit indices.

Again, research on how CMA relates to carbon strategies to enhance carbon performance should consider a longitudinal study to highlight how strategies change over time and how static or dynamic EMA relates to the changes (if any) in carbon strategies.



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Appendices

Appendix 1: Interview Guide

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This interview guide is to facilitate the collection of qualitative data as part of a PhD thesis in Accounting. The objective is to assess your motivation for carbon management accounting (CMA) practices, the CMA practices of your firm, the carbon risks and opportunities to which you are exposed, and the strategies deployed to deal with these risks/opportunities.

Your participation is entirely voluntary, and your responses will remain confidential. Your answers will be used solely for research and evaluation relating to the University. No individual participant or firm will be specifically identified in any reports or publications resulting from this study.

Thank you.

Please specify by checking the response that best applies to you and your firm.

Sex: Male ☐ Female ☐	Age: below 24 ☐ 25-34 ☐ 35-44 ☐ 45 and above ☐
Education: Secondary ☐ 1st Degree ☐ Masters ☐ PhD ☐	Discipline studied:
Position in the Firm: Duration of work with the Firm:	Industry: Manufacturing ☐ Agriculture ☐ Waste ☐ Energy ☐ Transport ☐

Motivation

1. What are your company's motivations for adopting carbon management accounting?

Governance

Oversight Body's Role in Governance Processes, Controls and Procedures

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2. What governance body exists to oversee Carbon Management Accounting (CMA) practices in your firm?
3. How are the CMA responsibilities assigned to the body?
4. How does the body responsible for overseeing CMA determine whether appropriate skills and competencies are available or will be developed to oversee strategies designed to respond to CMA?
5. How and how often is the body informed about carbon management practices in the company?
6. How does the body consider carbon-related risks and opportunities when overseeing the entity's strategy, its decisions on major transactions and its risk management processes?
7. How does the body oversee the setting of targets related to climate-related risks and opportunities, and monitor progress towards those targets?
8. Are performance metrics relating to carbon included in remuneration policies of that body? If yes, how?

Management's Role in Governance processes, controls and procedures

9. The engineering and operations branch entails engineering services, technical services, environment and sustainable development and thermal generation.
10. How is oversight exercised over these groups, especially the environment and development department?
11. What controls and procedures exist to support the oversight of climate -related risks and opportunities and how are these controls and procedures integrated with other internal functions?

Strategy

Carbon Related Risks and Opportunities

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12. What are the carbon-related risks and opportunities that could reasonably be expected to affect the prospects the company?
13. Over which time horizons—short, medium or long term— the effects of each risk and opportunity could reasonably be expected to occur.
14. Explain how the entity defines 'short term', 'medium term' and 'long term'?

    E.g.: 0-1 year 2 to 5 years 6 years and more
15. How are the definitions of short, medium and long term linked to the planning horizons used by the entity for strategic planning?

Effect of Carbon Emission on Strategy and Decision-Making

16. Are there current or anticipated changes in your entity's business model and resource allocation to address carbon-related risk and opportunities?
17. What are the current and anticipated mitigation and adaptation efforts to deal with the effects on your entity?

Effect of Carbon Emission on Financial position, financial performance and cash flows

18. What is the current effect of carbon-related risks and opportunities on the entity's financial position, financial performance and cash flows?

Risk management

19. How do you identify, assess, prioritise and monitor carbon-related risks?

20. How do you undertake carbon risk assessment?

Climate-related metrics

21. How do you measure greenhouse gas emissions?
22. Does your entity **classify emissions** as scope 1, scope 2 and scope 3?

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Appendix 2: Questionnaire For Firms in High-Polluting Sectors

UNIVERSITY OF GHANA BUSINESS SCHOOL

ACCOUNTING DEPARTMENT

This questionnaire serves as an instrument for data collection as part of the research requirement for a PhD in Accounting. The study seeks to evaluate the **effect of environmental management accounting on environmental performance with the mediation of green human resource management**.

Your participation in this exercise is entirely voluntary, and your responses will remain confidential. Your answers will only be used for research and evaluation purposes related to the University. **No individual participant or firm will be specifically identified in any reports or publications resulting from this study.**

Thank you.

Please specify by checking the response that best matches with you and your firm.

Sex: Male ☐ Female ☐	**Age**: below 24 ☐ 25-34 ☐ 35-44 ☐ 45 and above ☐
Highest Education: Secondary ☐ 1st Degree ☐ Masters ☐ PhD ☐	**Discipline studied:**
Position in the Firm: **Duration of work:**	**Industry**: Energy ☐ Agriculture ☐ Manufacturing ☐ Waste ☐ Transport ☐
Number of Employee:	**Company Ownership:** ☐ **Private** ☐ **State Ownership**

Please circle the correct numeric response to each question:

1 = Strongly Disagree 2 = Disagree 3 = Somewhat Disagree 4 = Neither agree nor disagree 5 = Somewhat agree 6 = Agree 7 = Strongly Agree

	Monetary environmental management accounting							
1	My firm identifies environment-related costs	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2	My firm estimates environment-related contingent liabilities (e.g. EPA fines)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3	My firm classifies environment-related costs	**1**	**2**	**3**	**4**	**5**	**6**	**7**
4	My firm allocates environment-related costs to production or service processes	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5	My firm allocates environment-related costs to products or services	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6	My firm introduces or improves environment-related cost management	**1**	**2**	**3**	**4**	**5**	**6**	**7**
7	My firm creates and uses environment-related cost accounts	**1**	**2**	**3**	**4**	**5**	**6**	**7**

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8	My firm develops and uses environment-related key performance indicators	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Physical environmental management accounting								
9	My firm carries out product/service life cycle cost assessments	**1**	**2**	**3**	**4**	**5**	**6**	**7**
10	My firm does product inventory analyses (i.e. the specification of the types and quantities of materials and energy required and the amount of residues released to the environment)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
11	My firm does product/service impact analyses (i.e. assessment of the environmental effect of products or services)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
12	My firm does product/service improvement analysis (i.e. identification of opportunities for reduction of environmental impact)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Green human resource management								
13	Environmentally conscious candidates are more valued by my firm	**1**	**2**	**3**	**4**	**5**	**6**	**7**
14	My firm can attract employees through environmental promises	**1**	**2**	**3**	**4**	**5**	**6**	**7**
15	My firm carries out environmental protection training for employees	**1**	**2**	**3**	**4**	**5**	**6**	**7**
16	My firm provides environmental training for management	**1**	**2**	**3**	**4**	**5**	**6**	**7**
17	Environmental responsibilities are included in the job description in my firm	**1**	**2**	**3**	**4**	**5**	**6**	**7**
18	My firm values staff participation in environmental issues	**1**	**2**	**3**	**4**	**5**	**6**	**7**
19	My firm selects employees based on environmental criteria when hiring	**1**	**2**	**3**	**4**	**5**	**6**	**7**
20	One of my firm's goals is green performance management and compensation	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Environmental performance								
21	My company has achieved important environmental-related certifications	**1**	**2**	**3**	**4**	**5**	**6**	**7**
22	My company has regularly achieved targets imposed on energy conservation, recycling and waste reduction	**1**	**2**	**3**	**4**	**5**	**6**	**7**
23	Due to its environmentally friendly practices, my company has saved a significant amount of money in the past (not including the achievements in terms of energy conservation, recycling or waste reduction)	**1**	**2**	**3**	**4**	**5**	**6**	**7**

INTEGRI PROCEDAMUS

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24	On average, the overall environmental performance of my company has improved in the past five years	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Appendix 3: Questionnaire For Manufacturing Firms

UNIVERSITY OF GHANA BUSINESS SCHOOL

ACCOUNTING DEPARTMENT

This questionnaire serves as an instrument for data collection as part of the research requirement for a PhD in Accounting. The study seeks to evaluate the **effect of environmental management accounting on environmental performance with the mediation of green human resource management**.

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Thank you.

Please specify by checking the response that best matches you and your firm.

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Highest Education: Secondary ☐ 1st Degree ☐ Masters ☐ PhD ☐	**Discipline studied:**
Position in the Firm: **Duration of work:**	Food and allied Pharmaceuticals & chemicals Paper & printing Ceramics Textiles Cement Others
Number of Employee:	**Company Ownerhip:** ☐ **Private** ☐ **State Owned**

Please circle the correct numeric response to each question:

1 = Strongly Disagree 2 = Disagree 3 = Somewhat Disagree 4 = Neither agree nor disagree 5 = Somewhat agree 6 = Agree 7 = Strongly Agree

Monetary environmental management accounting								
1	My firm identifies environment-related costs	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2	My firm estimates environment-related contingent liabilities (e.g. EPA fines)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3	My firm classifies environment-related costs	**1**	**2**	**3**	**4**	**5**	**6**	**7**

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4	My firm allocates environment-related costs to production or service processes	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5	My firm allocates environment-related costs to products or services	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6	My firm introduces or improves environment-related cost management	**1**	**2**	**3**	**4**	**5**	**6**	**7**
7	My firm creates and uses environment-related cost accounts	**1**	**2**	**3**	**4**	**5**	**6**	**7**
8	My firm develops and uses environment-related key performance indicators	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Physical environmental management accounting								
9	My firm carries out product/service life cycle cost assessments	**1**	**2**	**3**	**4**	**5**	**6**	**7**
10	My firm does product inventory analyses (i.e. the specification of the types and quantities of materials and energy required and the amount of residues released to the environment)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
11	My firm does product/service impact analyses (i.e. assessment of the environmental effect of products or services)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
12	My firm does product/service improvement analysis (i.e. identification of opportunities for reduction of environmental impact)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Environmental performance								
13	My company has achieved important environmental-related certifications	**1**	**2**	**3**	**4**	**5**	**6**	**7**
14	My company has regularly achieved targets imposed on energy conservation, recycling and waste reduction	**1**	**2**	**3**	**4**	**5**	**6**	**7**
15	Due to its environmentally friendly practices, my company has saved a significant amount of money in the past (not including the achievements in terms of energy conservation, recycling or waste reduction)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
16	On average, the overall environmental performance of my company has improved in the past five years	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Firm Competitive Advantage								
17	The use of pollution-preventive environmental technology reduces the internal environmental cost of the organisation	**1**	**2**	**3**	**4**	**5**	**6**	**7**
18	The use of pollution-preventive environmental technology reduces the external environmental cost of the organisation	**1**	**2**	**3**	**4**	**5**	**6**	**7**
19	The use of innovative technology helps to shape the strategy that reduces overall environmental costs	**1**	**2**	**3**	**4**	**5**	**6**	**7**

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20	Early adoption of an environmental management system supports environmental cost savings.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
21	The environmental cost advantage can be achieved through the application of environmental accounting	**1**	**2**	**3**	**4**	**5**	**6**	**7**
22	Being environmentally conscious can lead to substantial cost advantages	**1**	**2**	**3**	**4**	**5**	**6**	**7**
23	Our company has realised significant cost savings by improving the environmental quality of our products/services	**1**	**2**	**3**	**4**	**5**	**6**	**7**
24	By regularly investing in new eco-friendly technologies, processes and strategies, our company can be a leader in the market	**1**	**2**	**3**	**4**	**5**	**6**	**7**
25	Our company can enter lucrative new markets by adopting environmental strategies	**1**	**2**	**3**	**4**	**5**	**6**	**7**
26	Our company can increase service quality by making its current processes more environmentally friendly	**1**	**2**	**3**	**4**	**5**	**6**	**7**
27	Reducing the negative environmental impact of our company's activities will lead to a quality improvement in its products/services	**1**	**2**	**3**	**4**	**5**	**6**	**7**

INTEGRI PROCEDAMUS