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Carbon Management Accounting System and Corporate Environmental Performance: A Conceptual Framework

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INFO ARTIKEL

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Abstract

The heightened attention to climate change and the urgency to mitigate its impacts have compelled industries and companies to prioritize the reduction of their carbon emissions. In the study assumption, an effective Carbon Management Accounting System (CMAS) model could lead to sustainable Energy Efficiency (ENEFF) in achieving sustainable operations and overall enhancing Corporate Environmental Performance (CEP). This study comprehensively reviews previous research to develop a conceptual framework in which the relationship between CMAS, ENEFF, and CEP is drawn in the Malaysian Oil and Gaz industry. Such a relationship between these effective factors is supposed through two research models developed in the study: 1) the carbon management accounting model and 2) the corporate environmental performance model. Based on the model (1), the relationship between CMAS and energy ENEFF could be directly explored. Meanwhile, based on model (2), the relationship between CMAS and CEP could be explored directly and indirectly through the mediating role of ENEFF. The study paves the way for future research to examine both models developed as an integrated approach of CMAS effective towards ENEFF enhancement and overall CEP in the Oil and Gaz industry.

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Introduction

The heightened attention to climate change and the urgent requirement to tackle its effects have heightened companies' awareness of the need to prioritize the reduction of their carbon emissions. This underscores the extensive impact of carbon emissions on both the environment and global business activities. Consequently, companies must swiftly adopt measures to mitigate greenhouse gas (GHG) emissions, calling for comprehensive and sustainable solutions.

Conversely, it has been identified that companies' operations are the primary drivers of Carbon Dioxide (CO2) emissions and the subsequent rise in CO2 levels (Ong et al., 2022). In this regard, companies can rely on carbon accounting, which helps them manage and control the carbon dioxide (CO2) costs of their activities (Ong et al., 2022). This enables companies to align with stakeholder interests and enhance overall regional environmental performance (Linares-Rodríguez et al., 2022). Previous researchers (e.g., Bhargava et al., 2018; Gupta et al., 2019; Irfan et al., 2023) have highlighted various low-carbon strategies for improving Energy Efficiency (ENEFF). These include implementing carbon taxes and clean development mechanisms to address regional environmental challenges. As indicated by Nemecek et al. (2009), energy efficiency, as a low-cost mitigation strategy, has been a prominent topic in global policy discussions.

Furthermore, Dragomir (2012) reported that Corporate Environmental Performance (CEP) is a multifaceted variable that depends on measures such as recognition, measurement, verification, and reporting of CEP indicators. Scientific research has focused on measuring companies' environmental performance and examining its relationship with other firm-specific variables, such as company size, environmental strategies, disclosure practices, financial performance, and reputation.

However, in our extensive review of previous studies, we found that most studies have concentrated on the relationship between carbon accounting and corporate performance, carbon accounting and corporate environmental performance, and Carbon Management Accounting System (CMAS) and corporate performance. Additionally, Malaysia is poised not only to enhance the energy efficiency of its Oil and Gas industry through strategic management commitment and practices but also to integrate techniques like CMAS with energy efficiency and environmental performance enhancement. This will position Malaysia as a responsible global player in the transition towards a greener energy future.

This study extends previous research by developing a comprehensive conceptual framework that extracts the relationships between CMAS, ENEFF, and CEP. Therefore, the main objective of this research is to investigate the direct and indirect relationships between CMAS and ENEFF, as well as overall CEP. The structure of this study is presented as follows: sections two, three, and four critically review previous studies related to the carbon accounting system, energy efficiency, and corporate environmental performance. Section five reviews related studies on carbon accounting in Malaysia. Section six illustrates the conceptual framework developed in the study, and the theoretical and managerial implications of the framework are discussed in section seven. In section eight, the expected results are outlined, and the study is concluded.

CARBON MANAGEMENT ACCOUNTING

Carbon Accounting:

Carbon accounting is a systematic procedure involving the measurement, monitoring, and reporting of an organization's greenhouse gas (GHG) emissions. This encompasses both direct emissions from activities like fuel combustion and indirect emissions from purchased electricity. It serves as a tool utilized by scientists and financial analysts to tackle and mitigate GHG emissions and their impact on climate change, constituting a vital component of environmental accounting (Stechemesser & Guenther, 2012). The precision of carbon accounting is pivotal for comprehending the environmental impact of operations, establishing targets for emissions reduction, and ensuring transparency to stakeholders.

Achieving this necessitates informed decision-making regarding the tracking, tracing, management, and control of carbon performance (Burritt et al., 2011), a process effectively facilitated through the implementation of a Carbon Management Accounting System (CMAS).

Carbon Management Accounting:

As a sub-part of Carbon Accounting, Carbon Management Accounting (CMA) is a system that comes into play encompassing activities related to formulating strategies and plans, gathering pertinent information, and making informed decisions aimed at effectively reducing carbon emissions (Schaltegger & Csutora, 2012). In essence, Nartey (2018) reported that the organizational strategy, structure, environmental management accounting (EMA), firm size, technology, and perceived environmental uncertainty are found to be positively correlated with CMAS in Ghana. Moreover, the inter-organizational and intra-organizational arrangements enhanced the GHG emissions performance through CMA procedures in the U.S. (Mahmoudian et al., 2021).

ENERGY EFFICIENCY

Energy Efficiency (ENEFF) refers to the ability to accomplish tasks or achieve desired outcomes using less energy, thus reducing energy consumption and its associated environmental impacts. Strengthening ENEFF is a critical component of any sustainability initiative, involving the identification of opportunities to reduce energy usage while maintaining or even improving operational performance. This can be achieved through various measures, including equipment upgrades, the adoption of energy-efficient technologies, and the implementation of effective energy management practices. As emphasized by Zublie et al. (2023), enhancing ENEFF represents the most effective approach to reducing the costs associated with carbon dioxide emissions. This encompasses measures aimed at augmenting energy efficiency by reducing reliance on fossil fuels, ultimately mitigating the impact of greenhouse gases on climate change. According to Irfan et al. (2023), ENEFF emerges as a low-carbon strategy that can be deployed to address the escalating levels of carbon emissions. Additionally, ENEFF signifies a reduction in energy consumption for production, resulting in tangible energy savings (Irfan et al., 2023).

In their empirical study, Saidur et al. (2007) analyzed detailed data specific to Malaysia covering the period from 1995 to 2003 to evaluate the energy efficiency of various modes of transportation including land, water, and air. Their results reveal that, on average, road transportation exhibits the highest level of energy efficiency, followed by air and water transportation Meanwhile, Oh and Chua (2010) documented the evolution of Malaysian energy policies, highlighting the government's concerted efforts to reduce its carbon footprint through various energy efficiency initiatives. In addition, the study of Zublie et al. (2023) confirm that academic laboratory equipment, lighting, and air conditioning are vital to energy consumption in Malaysia. Liu et al. (2023) found that energy efficiency has both positive and negative effects on CO2 emissions in the long run in China. They recommended energy efficiency and environmental implications as prioritizing policies that improve energy efficiency. In the meantime, Wang et al. (2020) detected that the CO2 emissions were found to be closely related to energy consumption in the Chinese water-intensive sector. Recently, energy consumption reduction was found also to be significantly affected by environmental management

accounting in innovative activities of 55 Brazilian sectors (da Rosa et al., 2020). This creates further incentive for combining energy efficiency with carbon accounting and environmental performance in the proposed framework.

CORPORATE ENVIRONMENTAL PERFORMANCE

Environmental Performance:

Corporate environmental performance (CEP) refers to the effective activities with which a company manages and affects its environment. This encompasses the company's overall commitment, actions, and outcomes related to environmental sustainability. It encompasses a range of practices and initiatives aimed at minimizing environmental harm and promoting sustainability. These efforts include the adoption of efficient technologies, reduction of resource consumption, decrease in emissions, adoption of eco-friendly technologies, and implementation of waste reduction strategies. A high level of corporate environmental performance demonstrates a company's commitment to responsible business practices, often resulting in benefits such as cost savings, an enhanced reputation, and adherence to regulatory standards. Additionally, it signifies a company's recognition of its role in broader environmental stewardship and its contribution to a more sustainable future.

However, there is no commonly accepted definition of CEP and applied measures as well. According to Wagner and Schaltegger (2004), CEP should include business performance dimensions to provide a comprehensive view of environmental management's effects on firms' economic performance. Burritt et al. (2002) and Bartolomeo et al. (2000) initially developed a comprehensive framework of environmental management accounting in which management information could be split out into physical and monetary dimensions (see Figure 1).

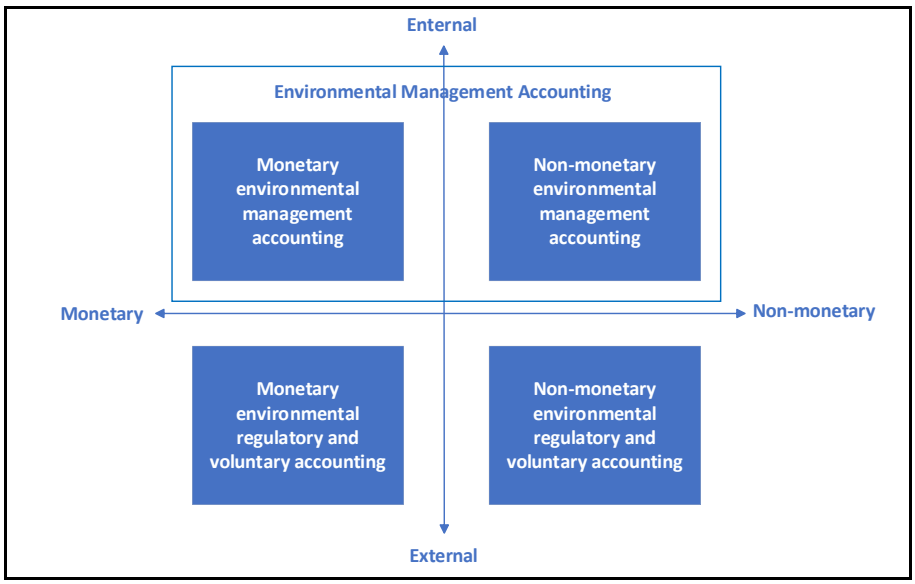

Figure 1: Environmental Management Accounting
Source: (Bartolomeo et al., 2000; Burritt et al., 2002)

In the framework, the time frame of decision making including past, present, and future is outlined. In addition, environmental accounting could be recognized at the firm's organizational, plant, regional, and national scales.

Environmental Performance Measures:

There are several measures of corporate environmental performance. Some researchers used measures, including financial and non-financial measures, related to environmental competitiveness, such as corporate image, product image, sales, market share, new market opportunities, short-term profit, long-term profit, cost savings, and productivity (e.g. Rahman & Islam, 2023; Wagner & Schaltegger, 2004). Other researchers used emissions and waste reduction, water abstraction, natural resource use, and raw materials extraction as measures of environmental performance (e.g. Dawkins & Fraas, 2011; Delmas, Lim, et al., 2015; Delmas, Nairn-Birch, et al., 2015). However, some measures related to the study topic include carbon footprint, energy consumption, waste generation and reduction, and water usage measures.

STUDIES ON CARBON ACCOUNTING IN MALAYSIA

The Oil and Gas industry plays a crucial role in the economy of countries, serving as a major contributor to government revenue and a significant source of employment. In Malaysia, for instance, as early as the 1990s, commendable strides were made in integrating sustainable practices within the Oil and Gas sector through a robust carbon strategy framework. This sector served as the primary energy source in the base year, and in both the 2025 scenarios, there is an anticipated increase in the use of Renewable Energy (RE) by about 4.5 times (Ho et al., 2013). One example of this integration is the implementation of a low-carbon city strategy, which employs sustainable development principles to achieve a high level of energy efficiency using low-carbon energy sources and production technologies (Ho et al., 2013). These technologies, often referred to as clean coal technologies (Siong et al., 2022), are instrumental in advancing environmental sustainability within the industry. Moreover, Gan et al. (2013) studied the low-carbon society outlook for Malaysia up to 2035. Their findings detected an unsustainable development trend, given an increase in spending on fossil fuels energy imports for coal, oil, and gas. Their study suggested an extensive use of renewable energy sources and promoted energy efficiency across all sectors, which could effectively address an over-reliance on fossil fuels and subsequently reduce CO2 emissions. This supports the argument that energy consumption in Malaysia is predominantly reliant on fossil fuels, which constituted 95.4% in 2016, as reported by the BP Statistical Review of World Energy in 2017 (Siong et al., 2022)

The government, in collaboration with industry stakeholders, has implemented a variety of initiatives to reduce carbon emissions and mitigate environmental impacts. These endeavors encompass investments in research and development of cleaner technologies, the adoption of renewable energy sources, and the promotion of measures to enhance energy efficiency. Additionally, both energy audit and energy efficiency are pivotal elements in the drive to curb carbon emissions. The awareness, knowledge, and commitment to energy conservation also play a significant role in achieving energy efficiency (Fernando & Hor, 2017). Furthermore, Malaysia has actively participated in international partnerships and commitments to uphold its environmental responsibilities in the face of climate

change. This includes its engagement in agreements such as the Kyoto Protocol and its contributions to the efforts of the Intergovernmental Panel on Climate Change (IPCC), demonstrating a commitment to reducing greenhouse gas emissions (Fernando & Hor, 2017). These collaborative efforts underscore Malaysia's determination to confront global environmental challenges.

CONCEPTUAL FRAMEWORK

The presence of a comprehensive framework for a Carbon Management Accounting System (CMAS) to support carbon management and control initiatives and activities is largely lacking. Therefore, this study seeks to address the ambiguity observed in previous research. The theoretical framework established in this study establishes a link between CMAS and Energy Efficiency (ENEFF) as the main determinants of Corporate Environmental Performance (CEP). Building on assumptions derived from related previous studies, it is posited that the integrated principles of these factors contribute to a sustainable, growth-oriented, and consistently maintained CEP. Figure (2) visually outlines the developed theoretical framework.

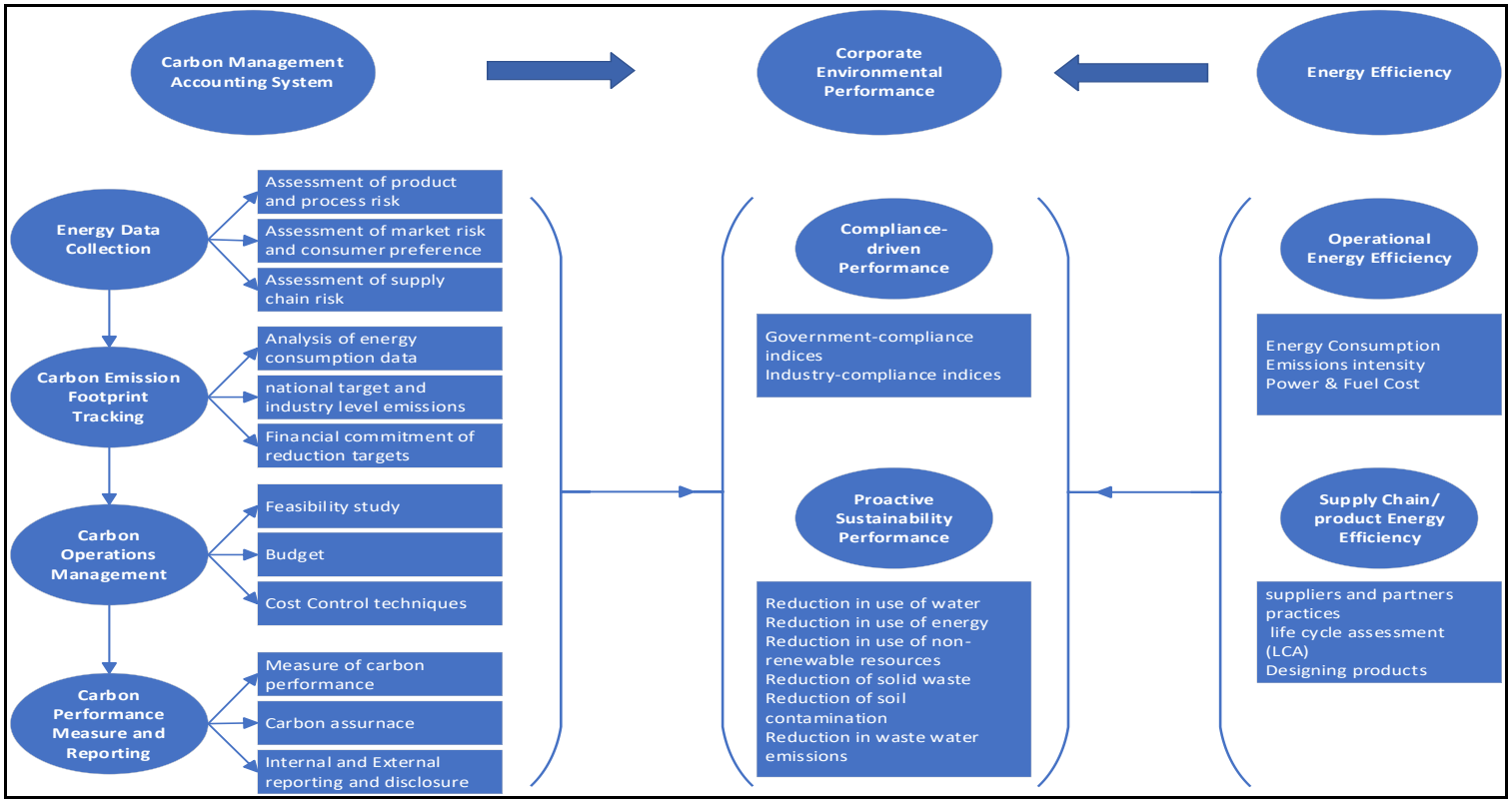

Figure 2: A Conceptual framework of CMAS, ENEFF, and CEP

As depicted in Figure (2), the framework highlights the interactive relationship between the Carbon Management Accounting System (CMAS), Energy Efficiency (ENEFF), and Corporate Environmental Performance (CEP). When effectively CMAS and ENEFF integrated, these components synergize to form a sustainable and resilient corporate performance model, striking a balance between economic prosperity and environmental stewardship. The framework is primarily constructed based on the findings of previous studies.

Previous research has predominantly focused on specific interactions within this framework. For example, certain studies have delved into the significant link between carbon strategy management and Energy Efficiency (ENEFF) (e.g., Chen et al., 2021; Rahman & Islam, 2023). Others have examined associations between Greenhouse Gas (GHG) emissions and firm performance (e.g., Al Kurdi et al., 2023; Bhargava et al., 2018; Linares-Rodríguez et al., 2022; Oh & Chua, 2010), as well as between carbon emissions and firm performance (e.g., Das, 2023; Irfan et al., 2023; Khatib et al., 2023; Ong et al., 2022). Notably, the study by Irfan et al. (2023) is the only one that specifically addresses the relationship between carbon emissions and energy efficiency.

Moreover, a study highly relevant to this study is the one conducted by Ong et al. (2022), which explores the mediating effect of carbon accounting on the relationship between carbon risk management and the carbon performance of Malaysian companies. However, from study perspective, the study may overlook the pivotal role of energy efficiency as a primary determinant of companies' performance when effectively managing carbon emissions through the adoption of carbon accounting techniques. This highlights an important aspect that warrants further investigation.

THEORETICAL AND MANAGERIAL IMPLICATIONS

Academic Implications

Upon reviewing previous studies, it has been consistently reported that an effective Carbon Management Accounting System (CMAS) leads to greater control over Greenhouse Gas (GHG) emissions (e.g., Chen et al., 2021; Pichancourt et al., 2018). However, none of the reviewed studies have extended the assessment of CMAS effectiveness to its impact on Energy Efficiency (ENEFF). In our study's assumption, companies with a more robust and precise CMAS are likely to demonstrate higher levels of ENEFF. This suggests that accurate tracking and reporting of carbon-related data may play a pivotal role in enhancing energy efficiency. Therefore, we hypothesize that the effectiveness and efficiency of a company’s CMAS are linked to its level of ENEFF.

Furthermore, previous studies have consistently affirmed that companies with effective CMAS tend to achieve higher levels of corporate performance (Stechemesser & Guenther, 2012). However, the metrics used to gauge corporate performance encompass both financial and non-financial aspects. Notably, the measurement of corporate environmental performance remains somewhat ambiguous in related previous research, especially when focusing on CMAS. In this study, we posit that the effectiveness and accuracy of a company’s CMAS are intrinsically connected to its overall Corporate Environmental Performance (CEP).

Examining the relationship between ENEFF and CEP is a crucial aspect of this study, particularly concerning sustainability and business practices. ENEFF, defined as the ability to achieve the same results with less energy, plays a pivotal role in reducing energy consumption and its associated environmental impacts. On the other hand, corporate environmental performance encompasses a company's overall commitment, actions, and outcomes in terms of environmental sustainability. Rahman and Islam's (2023) findings suggest a significant impact of ENEFF on environmental performance. However, the metrics used to evaluate environmental performance were somewhat unclear. In our current study, environmental performance is specifically focused on carbon-related issues, including carbon savings and emissions intensity. While previous studies have explored the influence of various factors (such as carbon risk management, carbon accounting, and carbon emissions) on CEP, research directly investigating the impact of CMAS on CEP is scarce. This presents an important gap in the existing literature.

The study conducted by Rahman and Islam (2023) established a significant positive impact of green accounting on both energy efficiency and environmental performance. Essentially, their findings affirmed that Energy Efficiency (ENEFF) serves as a significant and partial mediator in the relationship between green accounting and environmental performance, particularly in the case of environmental practices that have the highest impact.

In a separate study by Al Kurdi et al. (2023), it was observed that companies with lower carbon emissions demonstrate a greater willingness to enhance their environmental, social, and governance performance. Additionally, they discovered that carbon emissions play a significant mediating role in the relationship between the attributes of the board and environmental, social, and governance performance.

However, none of the previous studies have delved into the mediating roles of both the Carbon Management Accounting System (CMAS) and ENEFF when examining the relationship between carbon emissions and environmental performance. This indicates a notable gap in the existing literature. Consequently, the following conceptual model is proposed.

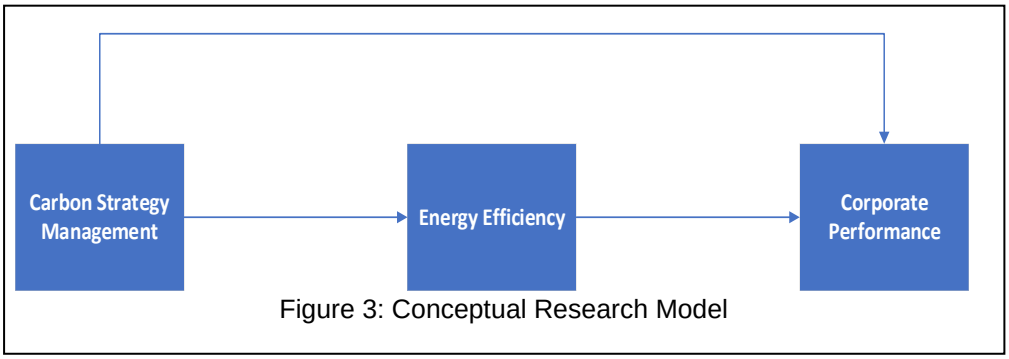

Figure 3: Conceptual Research Model

Future research can adopt a comprehensive toolkit to empirically explore the interplay between the Carbon Management Accounting System (CMAS), Energy Efficiency (ENEFF), and Corporate Environmental Performance (CEP) (refer to Figure 3). This toolkit encompasses a multifaceted approach, integrating a thorough review of prior studies and conducting archival data analysis through structured assessments. The critical examination of existing literature lays a robust

foundation for future investigations, supported by the development of a theoretical framework and subsequent conceptual research model.

Archival data analysis will involve a meticulous examination of historical records, financial reports, and sustainability disclosures to extract quantitative indicators of carbon performance. This process primarily relies on collecting and analyzing secondary data sourced exclusively from annual reports. It places particular emphasis on scrutinizing historical records, financial reports, and sustainability disclosures, with a specific focus on quantitative indicators of carbon performance.

By leveraging this extensive dataset, future research endeavors can offer valuable insights into the role of CMAS within the Oil and Gas sector in Malaysia. This approach will shed light on the intricate dynamics among CMAS, ENEFF, and CEP, contributing to a deeper understanding of their interrelationships.

Managerial Implications

The developed conceptual research framework highlights that companies have the potential to implement efficient strategies for managing their carbon-related initiatives, particularly by enhancing energy efficiency, to ensure effective Corporate Environmental Performance (CEP). These initiatives are closely linked to the utilization of Carbon Management Accounting System (CMAS) techniques and tools, encompassing strategic planning, financial and non-financial performance indicators, and financial reporting. Surprisingly, these crucial aspects have not received sufficient attention in existing literature.

It would be compelling to empirically validate this relationship before exploring the mediating role of CMAS in such a context. The assumption is that alterations in CMAS practices are correlated with corresponding changes in Energy Efficiency (ENEFF). This suggests that companies prioritizing and adeptly implementing carbon strategies are likely to demonstrate higher levels of energy efficiency and, consequently, achieve superior overall corporate environmental performance. Consequently, this study emphasizes the critical importance of leveraging archival data to glean valuable insights into sustainable business practices, as depicted in Figure (3) below:

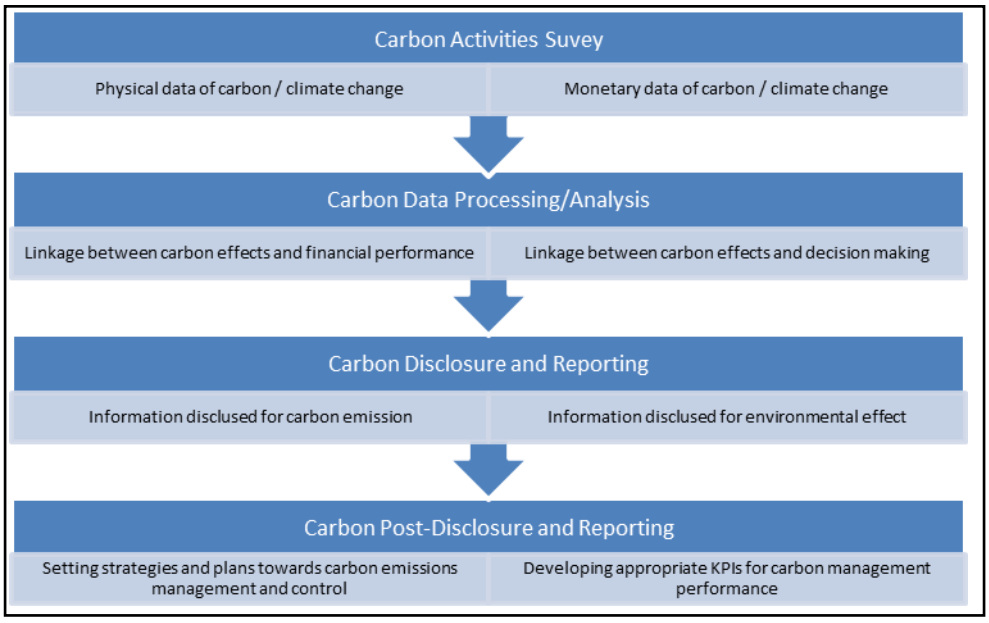

Figure 4: Managerial Implications of CMAS Framework

Through the processes illustrated in Figure (4), the management of the non-monetary and monetary carbon and the monitoring of carbon emissions on all levels of the value chain are recognized in a single cycle. The study's contribution is to shed light on the role of CMAS tools and techniques associated with the external supply chain and stakeholders. In brief, the framework developed provides information gathered both internally and externally to help companies recognize and evaluate carbon emissions reduction strategies and initiatives.

CONCLUSION

This study delves into the critical intersection of the Carbon Management Accounting System (CMAS) and Energy Efficiency (ENEFF) in potential effect on Corporate Environmental Performance (CEP). The study endeavors to unveil crucial insights into the intricate dynamics within this domain. Through a comprehensive review of pertinent literature, it seeks to make a substantial contribution to the discourse on sustainable business practices by offering theoretical insights into carbon management accounting strategies and their associated environmental outcomes, a comprehensive research framework was developed. The framework of this study holds potential implications for both theoretical and managerial perspectives. and business practicians. From the theoretical perspective, the conceptual framework developed endeavors to offer valuable insights for future researchers that can be used in empirically investigating CMAS techniques and their effect on corporate ENEFF and mitigating the overall CEP outcomes. From a managerial standpoint, this framework aids Oil and Gas companies in Malaysia by directing their attention towards carbon data sourced from both internal and external sources. This facilitates the development of strategies and initiatives aimed at reducing carbon emissions, while also promoting environmental performance within the corporate realm.

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