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THE ROLE OF CARBON TRADING IN ENHANCING SUSTAINABILITY METRICS AMONG MALAYSIAN MANUFACTURING FIRMS

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ABSTRACT

This study conceptualised a framework for the effective integration of carbon trading mechanisms (CTM) in the manufacturing industry. The imminent implementation of the CTM presented a pivotal opportunity for the manufacturing sector to significantly enhance sustainability performance. The framework enabled manufacturing industries to systematically identify, measure, and reduce their carbon emissions, thereby contributing directly to the country's carbon reduction goals and global efforts to combat climate change. This study proposed to examine the impact of the carbon trading framework on the sustainability performance of Malaysian manufacturing companies. To develop the framework of CTM and to examine the impact of the CTM framework on sustainability performance, this study employed both qualitative and quantitative approaches. The qualitative approach involved thematic analysis and in-depth interviews, while the quantitative approach utilised a structured questionnaire survey. The top management and policymakers of manufacturing companies could leverage data-driven insights from this study to make effective decisions about the design and implementation of carbon trading policies and improve sustainability performance.

Keywords: *carbon emissions, carbon trading framework, sustainability performance, manufacturing industry*

INTRODUCTION

Amidst escalating environmental challenges and the imminent threat of climate change, the global scenario has witnessed a significant rise in carbon dioxide emissions, primarily from the combustion of fossil fuels (Zhou, 2023). This unrestrained emission imperils the delicate ecological equilibrium and presents an existential threat to the sustainable development of human society. Against this backdrop, carbon emissions have become a focal point, prompting international efforts to curb greenhouse gas (GHG) emissions. The imperative to achieve net-zero carbon emissions, as underscored by international agreements like the Paris Agreement, demands a profound transformation in manufacturers' global economic systems (Ehigiamusoe et al., 2023). Within this context, Malaysia, an industrially advanced nation signatory to international agreements and protocols, emerges as a crucial player in the quest for a future of zero-carbon emissions. Global debates have led policymakers to integrate carbon trading to address the challenges of mitigating carbon emissions. Carbon trading, or carbon emissions trading, has received imminent attention in recent years. It involves using a marketplace to buy and sell credits that allow companies or other parties to emit a certain amount of carbon dioxide (Yu & Xu, 2023). Carbon markets enable investors and corporations to trade carbon credits and offsets simultaneously, mitigating the environmental crisis and creating new market opportunities. Its purpose is to limit climate change by creating a market with limited allowances for emissions. Carbon markets help channel financial resources to support emissions reduction or removal activities globally, which would otherwise not be implemented due to factors such as insufficient policy and economic incentives.

The imminent implementation of the carbon trading mechanism (CTM) in Malaysia, slated for December 2023,

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presents a pivotal opportunity for the manufacturing sector to contribute substantially to environmental sustainability (Zainuddin, 2021). However, the nascent stage of this initiative in Malaysia underscores the absence of a tailored and robust framework to effectively integrate carbon emission offset projects within the manufacturing industry. This deficiency is attributed to uncertainties and disadvantages associated with the current implementation, hindering the optimal functioning of the CTM. While developed countries have established frameworks for effective carbon trading measurement, Malaysia lags in providing a dedicated structure for measuring and implementing CTM within its manufacturing sector. This deficiency exhibits the challenges faced by industry stakeholders in navigating the complexities of carbon trading, limiting their ability to harness its full potential (Mashari et al., 2023).

Furthermore, the dearth of a standardised framework poses a significant barrier to achieving meaningful carbon emission reductions and sustainable business practices in the Malaysian manufacturing sector. It also hampers the country's ability to align with international standards and commercialise emerging opportunities in our global carbon market (Jiang et al., 2023). Many developed countries have successfully integrated CTM (Hamzah et al., 2019). However, Malaysia faces unique contextual challenges that necessitate a tailored approach. The absence of a locally relevant framework inhibits the sector 's ability to comply with impending regulation and undermines the potential economic benefits associated with carbon trading. Therefore, research is urgently needed to address this critical gap by developing a comprehensive and practical framework for effectively integrating CTM within the Malaysian manufacturing industry. Such a framework will provide clarity, transparency and guidance for industry stakeholders, policymakers, and businesses. Therefore, this study conceptualises a comprehensive and robust framework for the CTM within the Malaysian manufacturing industry.

A well-crafted carbon trading framework will empower manufacturing industries to systematically identify, measure, and reduce carbon emissions (Hu et al., 2023). This reduction is critical for mitigating the environmental impact of industrial activities, directly contributing to the countries' carbon reduction goals and global efforts to improve overall sustainability performance (Hao et al., 2023). Moreover, the framework will enable companies to monetise their carbon reduction efforts through the trading of carbon credits. In this regard, this economic incentive promotes financial gains for businesses and encourages ongoing efforts to improve energy efficiency and reduce emissions, creating a self-sustaining cycle of environmental responsibility and economic viability. In essence, the framework will serve as a catalyst for a paradigm shift within the Malaysian manufacturing sector, fostering a more sustainable and environmentally responsible industry. Therefore, the initiative to develop a robust framework will provide a comprehensive framework to Malaysian manufacturing companies and improve their commitment to sustainability performance. Conclusively, this study has proposed two main objectives as follows:

RO1: To develop a robust carbon trading framework for the Malaysian manufacturing sector.

RO2: To examine the influence of the Carbon trading framework on sustainability performance (Economic, Environmental, Social) in the Malaysian manufacturing industry.

The rest of the document is organised as follows: The next section presents the literature review. The conceptual framework of this work is provided in the subsequent section, followed by the research methodology. Then, this study proceeds with a conclusion. Finally, the research implications and recommendations for future research are presented.

LITERATURE REVIEW

Carbon Trading Mechanisms (CTM)

Carbon trading is a market-based system designed to reduce GHG emissions and combat climate change. It works on a cap-and-trade principle, where governments or regulatory bodies set a limit on the total amount of certain GHG that can be emitted (Jia & Lin, 2020). Organisations that emit these gases are issued emission allowances or permits up to the cap amount. Those who emit less than their allowance can sell their extra permits to organisations that exceed their limits, creating a market for carbon credits. This approach incentivises organisations to reduce emissions and invest in clean technologies (Fawcett & Parag, 2017). The CTM is also important for sustainable development, assisting developing countries

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in advancing their socio-economic development while transitioning to a low-carbon economy. In this sense, Zhang et al. (2020) mentioned that the implementation of carbon trading is conducive to regional sustainable development and controls environmental pollution. Carbon trading frameworks differ across countries due to various factors such as political limits to financial transfers between countries, differing national contexts and development levels, social and political circumstances, market failures, externalities, and biases in behaviours, among others. The existence of different types of carbon markets, such as mandatory (compliance) schemes or voluntary programmes, and the level of regulation and centralisation of carbon trading platforms also contribute to these differences. Furthermore, the ability of countries to link their carbon markets successfully depends on factors such as the solid grounding of emissions trading systems in the national legal framework, the existence of strong and credible emission reduction targets, and the availability of natural carbon sinks. Therefore, the differences in carbon trading frameworks across countries are shaped by a combination of political, economic, social, and environmental factors that are unique to each country.

Different studies have developed the carbon trading framework with its measurement. For instance, Jin et al. (2020) performed an empirical study in China by integrating the concept of carbon trading in the power industry. This study measured carbon trading by indicators such as the total transaction volume, market turnover, and the number of market transactions. Verde and Borghesi (2022) measured carbon trading by evaluating carbon market trading efficiency, market liquidity, and regulatory effectiveness. Furthermore, Augustine et al. (2022) provided a conceptual framework for carbon trading in the construction industry, including factors such as carbon footprint, carbon credits, and carbon offsetting. In addition, Bai et al. (2023) utilised a CTM to improve green innovation from two perspectives. The first perspective considers the purpose of implementing the CTM, including industrial structure adjustment, energy structure upgrading, green technology innovation, and the impact of human capital. The second perspective focuses on the effect of the CTM on foreign direct investment (FDI) as a market-oriented approach.

In Malaysia, there is no stringent legal framework for carbon trading to support the country's target of reducing emissions to net zero by 2050. However, there is a growing need for a carbon trading framework to support the country's low-carbon transition. According to the International Carbon Action Partnership report, Malaysia is well-positioned to be a potentially ideal hub for carbon-related initiatives since it demands carbon offsets. The National Policy on Climate Change (NPC) is set to provide guidance for carbon trading at the state level, and the Malaysia Climate Change Action Council is spearheading these efforts. To fill up this pertinent gap, this study is conceptualised to develop a framework for CTM within the Malaysian manufacturing sector.

Sustainability Performance

The concept of sustainability within manufacturing organisations implies a focus on serving the needs of the organisation's direct and indirect stakeholders (Shad et al., 2020). It involves integrating sustainable practices into business operations to achieve long-term economic, environmental, and social performance. Sustainability performance acts as the guiding principle for organisations, driving leadership, investment, and operational decisions toward creating value and superior business performance for partners and communities. The concept of sustainability performance includes three key aspects: environmental, social, and economic. Environmental performance refers to the responsible use of natural resources and the protection of global ecosystems to support the well-being of current and future generations (De Silva Lokuwaduge & De Silva, 2020). It encompasses maintaining an ecological balance and conserving resources such as clean air, water, and wildlife. Environmental sustainability is important for preserving resources and ensuring a high quality of life for future generations. This can be achieved through practices that minimise waste, reduce resource consumption, and mitigate environmental impact.

Regarding the significance of environmental sustainability, it maintains the health and biocapacity of the environment, supporting the well-being of individuals and communities and promoting a better economy with little waste, pollution, and fewer emissions (Shad et al., 2018). The second pillar of sustainability performance is economic sustainability, in which organisations have always placed a high

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value on priorities (Shad et al., 2019). Economic sustainability performance aims to enhance the market value of organisations (Shad et al., 2022). Economic sustainability encompasses financial benefits and indicates an organisation's long-term financial viability and profitability (Jan et al., 2019; Lai et al., 2018; Mukhtar et al., 2023a). The final pillar of Triple Bottom Line (TBL) is social sustainability, which incorporates various social aspects such as equality, employee development, health safety, equal opportunities for advancement, and contribution toward community welfare activities (Lai et al., 2017; Torkayesh et al., 2021). Organisations should focus on economic and environmental perspectives and pay more attention to social performance (Hamad et al., 2023).

Sustainability performance enables organisations to perform better than their competitors for a short and long period of time (Mukhtar et al., 2023). From a financial perspective, which is the main objective of any organisation, sustainability performance significantly impacts on organisational success through accounting indicators such as profitability, investment turnover, and sales (Mukhtar et al., 2023). From a non-financial perspective, sustainability performance raises the level of customer satisfaction and societal well-being. Embracing sustainability is crucial for reversing climate change, and its benefits extend beyond nature, providing numerous commercial and financial benefits to organisations (Shad & Lai, 2019; Nurul et al., 2023). Developing sustainable business practices enhances operational efficiency, conserves resources, and streamlines corporate efforts, leading to higher employee productivity and lower production costs. Becoming sustainable means a reduction in energy usage, more efficiency, less waste, less pollution, and a reduction in liability (Yu et al. 2020). Regarding the second objective of this study, it is important to propose to examine the influence of the carbon trading framework on sustainability performance. The impact of the carbon trading framework on sustainability performance has been extensively researched. Several studies have shown that carbon trading significantly affects environmental sustainability. For instance, He and Song (2022) revealed that carbon emission trading positively influences environmental sustainability by integrating and leading to a higher preference for renewable energy. Similarly, Huang et al. (2023) demonstrated that carbon trading systems significantly reduce carbon dioxide emissions and improve the environmental sustainability of manufacturing companies.

Furthermore, Yu and Xu (2023) performed an empirical study in China, emphasising the effectiveness of both the carbon trading system and sustainable energy strategies on environmental sustainability. These findings collectively suggest that carbon trading can play a significant role in promoting environmental sustainability. Conclusively, it can be inferred that the impact of CTM to improve sustainability performance, including economic, environmental, and social performance is not yet evident. As a result, this study is proposed to examine the impact of robust carbon trading framework on the sustainability performance of the Malaysian manufactory industry, including economic, environmental, and social aspects.

CONCEPTUAL FRAMEWORK

The framework for CTM has been developed by adapting the dimensions from prior studies, as shown in Figure 1. As outlined in the methodology, these dimensions will undergo modification or incorporation of new elements during the thematic analysis. In this case, the analysis will focus on refining and enhancing the dimensions of the carbon trading framework to make it applicable to the specific context of Malaysian manufacturing companies. In this way, the proposed study aims to present a robust framework for CTM tailored to the Malaysian manufacturing sector. Subsequently, as indicated in Figure 1, the proposed research will investigate the impact of the finalised comprehensive carbon trading framework on sustainability performance within Malaysian manufacturing companies.

RESEARCH METHODOLOGY

This study is conceptualised to develop a comprehensive framework for the CTM. In addition, this study is proposed to examine the impact of the carbon trading framework on sustainability performance. To develop a comprehensive CTM framework, this study is proposed to deal with qualitative analysis through thematic analysis. The initial framework will be developed by adapting from existing dimensions of CTM. To refine the developed framework, a qualitative thematic

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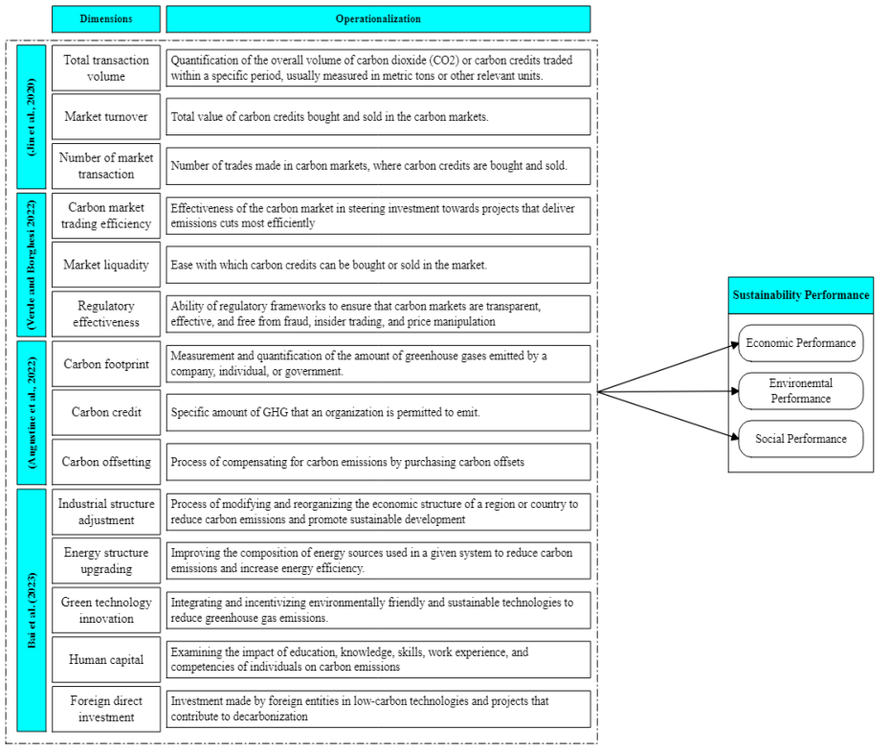

Figure 1 Conceptual framework

analysis and in-depth interviews will be conducted with senior officials from the manufacturing industry. Open-ended questions focusing on the themes and factors included in the carbon trading framework will be generated to facilitate the interviews. Informants will be asked for their consent to record sessions, and each interview will be transcribed and analysed using ATLAS. TI software. Once the thematic analysis is complete, the dimensions of the carbon trading framework will undergo modification or incorporation of new elements. Subsequently, a structured questionnaire will be used to examine the impact of CTM on sustainability performance, as most organisations have no formal data on CTMs. The questionnaire will be adopted from previous studies as well as established surveys (Mukhtar et al. 2023). Respondents will select the most suitable option on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) (Mukhtar et al., 2024). The survey instrument will be tested through a pilot study before being distributed to all respondents. After ensuring the rationality and validity of scale, official data collection from the senior officials of Malaysian manufacturing companies will be processed. The collected responses will be utilised for data analysis, which will be conducted using the PLS-SEM (Partial Least Square-Structural Equation Modelling) technique in SmartPLS4.0 software (Mukhtar et al., 2023).

RESULTS AND DISCUSSION

The lack of a robust framework for seamlessly incorporating CTM is a significant obstacle that hinders the efficient operation of such systems. At its core, carbon trading is a market-based approach that aims to incentivise the reduction of GHG emissions by allowing entities to buy and sell emission allowances or credits. However, the absence of a well-defined and harmonised framework can create a range of issues that undermine the effectiveness of these systems. One of the key challenges is the lack of standardisation and consistency across different carbon trading schemes. Without a cohesive set of rules, regulations, and methodologies, the trading of carbon credits becomes fragmented and complex, making it difficult for businesses and organisations to navigate the system effectively. This fragmentation can lead to discrepancies in the valuation of carbon credits, creating uncertainty and hindering the development of a robust and liquid carbon market.

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Furthermore, the lack of a robust framework can also raise concerns about the integrity and transparency of CTM. Ensuring the accurate measurement, reporting, and verification of emissions reductions is crucial to maintaining the system's credibility and preventing the risk of double-counting or fraudulent activities. Without a well-established framework, these critical aspects of carbon trading can become compromised, undermining the system's overall effectiveness.

Additionally, the absence of a comprehensive framework can hinder the integration of CTM with other sustainability initiatives and policies. Effective carbon trading systems should align with broader environmental and economic goals, such as renewable energy deployment, energy efficiency improvements, and the transition to a low-carbon economy. Integrating carbon trading with these complementary efforts becomes challenging without a cohesive framework, limiting the potential for synergies and holistic solutions. As a result, this problem highlights the urgent need for research to develop a tailored framework for CTM. To address this gap, this study is conceptualised to develop a comprehensive framework for the CTM within the Malaysian manufacturing sector. The framework may empower manufacturing industries to systematically identify, measure, and reduce their carbon emissions. The framework will be validated as a trustworthy measurement of carbon trading for the long-term viability of Malaysian manufacturing companies.

Conversely, the existing literature does not clearly indicate the impact of the carbon trading framework on sustainability performance, including economic, environmental, and social performance, in the Malaysian manufacturing industry. The carbon trading framework is crucial for tackling global climate change and ensuring Malaysian producers remain globally competitive. However, the existing research lacks empirical evidence on the impact of the carbon trading framework on sustainability performance in the Malaysian manufacturing industry. Pertaining to this academic gap, this study proposes to examine the impact of the carbon trading framework on sustainability performance, encompassing economic, environmental, and social sustainability performance. It is suggested that this study adopt a mixed-method approach, including qualitative analysis through thematic analysis and in-depth interviews, as well as a quantitative analysis through a structured questionnaire.

CONCLUSIONS

This study offers several implications for research and practice. Firstly, the literature lacks a clear framework for carbon trading in manufacturing companies and its impact on sustainability performance among Malaysian manufacturers. This study enriches existing literature by providing a comprehensive carbon trading framework. Secondly, this study developed a framework for the carbon trading mechanism (CTM) within the manufacturing sector, empowering industries to systematically identify, measure, and reduce their carbon emissions. The framework will be validated as a reliable measurement for the long-term viability of Malaysian manufacturing companies. Thirdly, this study proposes to investigate the impact of CTM on sustainability performance (environmental, social, and economic). This is the first attempt to empirically examine the relationships between CTM and sustainability performance, offering a novel contribution to current literature. Fourthly, this research may guide policymakers in developing policies to enhance CTM and sustainability performance. Fifthly, this study provides investors with a comprehensive approach to analysing investment opportunities in terms of integrating CTM and enhancing sustainability performance. Finally, it ensures practitioners and managers can recognise key areas for improvement and develop strategies to promote sustainability performance. This study also highlights the need for future research to validate the CTM framework and its impact on sustainability performance using both qualitative and quantitative approaches.

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