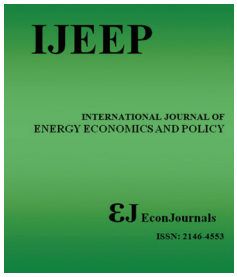

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The Mediation Effect of Carbon Accounting in Relation to Carbon Risk Management and Carbon Performance of Malaysian Companies

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ABSTRACT

This paper enhances the knowledge on carbon management among organizations certified by the Malaysian International Organization for Standardization (ISO) 14001. Specifically, the study investigated the impact of carbon risk management on carbon performance through the mediation of carbon accounting. This research adopts a quantitative method with a final sample size of 136 and structural equation modeling (SEM) was employed to analyze the data. The findings suggest that carbon risk management and carbon accounting have a significant positive effect on carbon performance. Notably, carbon accounting exerts a full mediating effect on the relationship between carbon risk management and carbon performance.

Keywords: Carbon Risk Management, Carbon Performance, Carbon Accounting, ISO 14001
JEL Classifications: M410, M140, Q56

1. INTRODUCTION

Industry and industrial usage have been identified as the key contributors to carbon dioxide (CO2) emissions and growing CO2 levels (UNDP, 2013; van der Hoeven, 2011), despite a reluctance to embrace green technology and a desire to continue with business as usual. Carbon emissions degrade the environment and have an impact on company operations in every country on the planet. Organizations must therefore take action to mitigate greenhouse gas emissions, which requires widely synchronized resolutions. In this regard, carbon accounting can help concerned organizations deal with their CO_2 emissions. Carbon accounting refers to the practise of facilitating the measurement and monitoring of carbon emissions in order to inspire greater performance, as measuring, documenting, and communicating are key accounting principles. Accountants play a critical role in the development and implementation of carbon accounting. To aid them, the Association of Chartered Certified Accountants (ACCA) has issued guidelines on carbon accounting so that it is simple and accessible to all entities, regardless of size. That way, businesses are not discouraged by the complexity or time involved in generating carbon accounts. The simplest carbon accounting guideline, developed by ACCA and Green Accountancy in the United Kingdom, starts by narrowing down the reporting scope to business activities that significantly involve emissions. The guideline also provides reporting form, methodology, and even conversion factors (e.g. energy usage to emissions in metric tons) to encourage more organizations to protect the environment, boost business growth, and cut costs (York, 2015).

Carbon accounting is imperative in various aspects. Economically, with the right guidance, carbon accounting can identify the business activities that over consume energy, which decreases not just energy and resource usage but also operating costs. Lower costs allow more attractive prices to be set without affecting profit margins, which would draw customers and subsequently improve financial performance. In terms of social development, the use of carbon accounting attracts the right employees, customers, and investors who strongly support green business and believe in growing together environmentally and financially. As such, a company that demonstrates improved carbon transparency through carbon accounting will engender the trust and loyalty of its stakeholders. From an environmental perspective, carbon accounting gives you the tools you need to systematically measure carbon emissions and make educated mitigation decisions. Therefore, the information generated from carbon accounting enhances organizations' environmental awareness and carbon performance (Alrazi and Husin, 2016). This essentially results in genuine change that helps to accomplish the sustainable development goals (SDG).

Ultimately, carbon management strategies and carbon accounting have become critical in the current business sphere. Proactive companies that have embedded carbon strategies undertake holistic approaches to effectively instill carbon-conscious thinking into their business practices to achieve their green mission and higher profits. Nevertheless, a corporate carbon strategy must be in alignment with specific carbon policies as well as the organization's overall business strategy, which depends entirely on its business nature and regulatory setting (Wahyuni and Ratnatunga, 2015). As a strategy is a multidimensional construct, prior studies lack a justification of which environmental strategic networks influence a company's carbon accounting system and, consequently, its performance (Bui, 2017). Besides lack of justificaitions, these sustainability efforts are assumed to be costly, complicated, and subjective to measure (Kasbun et al., 2016). Given that Malaysia needs prudent strategies for climate-friendly growth to reach sustainability goals (Shahid et al., 2014), this study proposed that the implementation of carbon accounting, which is influenced by an organization's carbon risk management as a strategy, is the driving force behind improved carbon performance.

2. LITERATURE REVIEW

2.1. Carbon Risk Management

Climate change or carbon emissions are identified as a business risk, while actions taken by organizations to avoid or solve possible risk occurrences are considered risk management. Risk management includes identifying, measuring, assessing, and treating risks that not only cause negative consequences for performance but also bring opportunities to increase organizational value (Bui and de Villiers, 2017; COSO, 2004). Since the Kyoto Protocol ratification as well as the introduction of the Emission Trading Scheme (ETS) and other carbon emission regulations for environmental preservation across regions like Europe, Australia, and New Zealand, carbon emissions and related carbon footprint matters have been regarded as risks but also opportunities for organizations. Such risks and opportunities justify the incorporation of a carbon accounting system into corporate risk management (Bui and de Villiers, 2017).

Deloitte (2007) stressed that when a company makes capital investment decisions following a carbon emission reduction strategy, they confront major strategic risks related to the existence of technology to capture carbon information and carbon pricing. The unavailability of technology to alleviate a company's carbon emissions instigate technological risk and associated costs due to the use of fossil fuel to generate electricity. Market risks also arise from carbon price variations and differences in companies' capability to relay carbon-related costs to consumers (Deloitte, 2007). Likewise, Bebbington and Larrinaga-González (2008) suggested that carbon credit market value instability creates difficulty in measuring compliance costs and increases pressure on organizational performance and risk management. Compliance costs, which refer to all expenses that an organization has to bear to abide by industry regulations, are possible risks for organizations with high carbon emissions. In contrast, low carbon emission companies do not incur such costs and thus have the opportunity to offer cheaper products or services. In addition to carbon dioxide emissions risks, companies may expose themselves to regulatory risks. For example, international pressure may exist despite the government's failure to implement envisioned carbon emission reduction strategies. Such uncertainty can spark companies' efforts to choose a proper strategic response because they are unable to foresee the likelihood or consequences of regulation. Conversely, when carbon emission regulations are certain, companies can estimate expected compliance costs in various areas, such as carbon price variations or the availability of carbon mitigation technology. Based on such assessments, organizations can convey proper responses like investing in renewable or eco-friendly technologies (Bui and de Villiers, 2017). Ultimately, there are possibilities for all these risks to emerge even when climate change policies or regulations have been introduced. However, Butterworth (2015) stated that so far, no study has investigated the impacts of regulatory uncertainty on the design and implementation of management control systems (MCS) related to risk management strategies that reduce CO_2.

Nevertheless, carbon emission issues and possibilities are highly unpredictable; therefore, the impacts of accumulated carbon emissions could be more challenging to recover compared to other risks, such as economic or political risks. Thus far, only in study on corporate modifications to climate change's physical repercussions has risk management been discussed in relation to climate change. (Weinhofer and Busch, 2012; Wilby and Vaughan, 2011). Though risk management also involves the assessment of risks and opportunities related to climate change mitigation (Tang and Luo, 2014) and the link between risk management and managerial accounting has been recognized in the literature, only a few studies offer empirical conclusions on this relationship (Mikes, 2009). There is also limited evidence on the interrelations between regulatory risks, internal organizational risks, and organizations' management control systems to manage such risks, such as carbon emission management schemes (Butterworth, 2015). The gaps in this area call for more research efforts to avoid unsustainable business activities and resolve carbon footprint issues in Malaysia through cooperation from industry players.

2.2. Carbon Accounting

Climate change has transformed from a scientific issue to a widespread social and political concern. Carbon dioxide emission is the major sustainability problem causing climate change issues that impact the environment, economy, society, and business circles. The pressure surrounding carbon emissions has led corporations to address this issue in their organizational strategic setting. With that, international efforts and national strategies have emerged to cope with the carbon emission of firms (Karlsson et al., 2014). Among these efforts, over the past decades, scientists have generated multiple forms of carbon accounting to assess the global carbon cycle and the carbon budget that have increased carbon dioxide atmospheric levels since the mid-1960s. The specific term 'carbon accounting' can be traced back to 1991, when it was originally used by practitioners to measure the carbon stored and released in forests and other shapes of biomass. Practitioners then developed new national measures for climate change accountability which used a similar terminology, such as nationwide greenhouse gas inventories under the UN Framework Convention on Climate Change (UNFCCC) 1992. Academic lines and other fields started using the term 'carbon accounting' more generally since 2008 (Ascui, 2014).

In this regard, organizational carbon accounting has experienced a major transformation over the last 20 years from an extensive functionality with distinctive features to a special area of environmental management accounting (EMA) that draws attention (Csutora and Harangozo, 2017). Besides guaranteeing regulatory compliance, carbon accounting is beneficial for internal decision-making, continuous improvement, and external reporting (Henri and Journeault, 2010). Carbon accounts can also be the basis for carbon management actions aimed to improve climate change-related performance, compensate for or proactively reduce current emission levels, and switch to carbon independence (Weinhofer and Hoffmann, 2010). According to Csutora and Harangozo (2017), carbon accounting has been in business frameworks and management accounting research for the last 20 years, yet crucial questions and key insights about carbon accounting have evolved and remain elusive.

Given that carbon accounting involves various extensive practices which implicate many fields, it has no sole clear definition (Stechemesser and Guenther, 2012); however, this notion encompasses a wide variety of actions relating to the computation, verification, reporting, and measurement of carbon emissions (Burritt and Tingey-Holyoak, 2012). Luo and Tang (2016) state that carbon accounting is "…a means to operationalize the company's carbon strategy and policy to improve input efficiency, lessen risk and emissions, evade compliance costs, and enhance competitive advantage." Tang (2014) defined carbon accounting as a system that operationalizes accounting methods and procedures to accumulate, record, and evaluate information related to climate change, including carbon-related assets, liabilities, expenses, and income, to aid internal managers and external stakeholders in decision making. Tukker et al. (2020), from the accounting perspective, termed carbon accounting as a calculation approach of carbon emissions using extended input-output databases, including consumption, production, and income. Next, Hespenheide et al. (2010) provide a definition of carbon accounting that specifies emission measurement and elimination on one hand and financial consequences on the other. This definition relays the satisfaction of non-monetary and monetary bottom lines as well as the internal and external application of carbon accounting to incorporate climate change mitigation features. Meanwhile, Kolk et al. (2008) defined carbon accounting as "the instrument to calculate CO_2 quantum either emitted or sequestered in a biomass sink is carbon accounting." Schaltegger and Csutora (2012) distinguish carbon accounting at the scientific, political, economic, and business levels. Major emission trends, awareness growth, and directions on the management and reduction of carbon emissions to keep within the sustainability scope are all part of scientific carbon accounting (Schaltegger and Csutora, 2012). Stechemesser and Guenther (2012) also categorize carbon accounting at the international, national, industrial, and corporate levels, emphasizing the distinct scopes of the carbon accounting field. They further suggest that at the management or corporate level, the term 'carbon management accounting' should be used instead of "carbon accounting" because management accounting covers a broader and more strategic domain.

Carbon accounting tools and their outcomes are complex, which may cause organizations to neglect its benefits to nature (Gibassier et al., 2020). However, new forms of accounting like carbon accounting are a significant asset to the environmentally conscious community, as it helps achieve harmonious connections between human beings and their natural surroundings (Hopwood, 2009). Carbon accounting, which plays a vital role in sustainable development, supports the expansion of economical short-term accounting practices to consider not just an organization's direct impacts and interactions but also its impacts on the society and environment in which the organization operates.

2.3. Carbon Performance

Corporate environmental performance is a multidimensional construct, such that the way it is defined and measured affects empirical outcomes in research (Guenther and Hoppe, 2014). Graham and Potter (2015) found that environmental practices like energy reduction, waste reduction, supplier and customer collaborations, and active involvement in strategic environmental orientation can improve environmental performance. Jacobs et al. (2010) further asserted that improved environmental performance is expected to provide access to new markets, lower costs, and enhance overall performance. A specific aspect of environmental performance is carbon performance, which is described as a reduction in the absolute amount of discharge into the environment and an increase in efficiency through less greenhouse gas emissions per kilogram of product or functional unit of a company (Schaltegger and Csutora, 2012). Many emissions produced by companies' operations are possibly hidden by other emissions either through the upstream or downstream value chain partners. For example, emissions from energy provision or product usage are rarely covered in emissions reports. To improve the reliability of carbon assessments and monitor performance differences at the organizational level, indicators that precisely measure a company's carbon performance are necessary (Hoffman and Busch, 2008).

Carbon performance brings more opportunities as it transforms negative associations to positive associations, which later entails financial benefits (Lewandowski, 2017). However, the lengthy process of policy and legislative changes limits firms' capability to enhance carbon performance, which conveys negative messages to business players who are proactive about climate change (Qian et al., 2020). Companies thus have little incentive to improve their carbon performance beyond a minimum level. Further, Lewandowski (2017) stated that despite growing regulatory pressure to report carbon performance, companies remain ineffective in tackling climate change even though financial performance will clearly improve from better carbon performance. Another issue is that although more companies report carbon information in their climate change strategy and carbon performance documentation, investors are still not ready or not willing to use this information for investment decision-making (Sullivan and Gouldson, 2012). Nevertheless, the public's growing interest in carbon performance and their demand for carbon-related information have pressured governments to regulate new carbon-related directives or add carbon-related aspects to existing policies (Dwyer, 2002; Jenkins and Yakovleva, 2006). Consistent with the resource-based theory (RBT), it can be contended that companies actively engaged in sustainability activities or sustainability reporting (i.e. carbon accounting) will benefit from rising share prices, superior competitive advantage, and ultimately, high organizational performance.

3. CONCEPTUAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

The resource-based view (RBV) is an important theory in strategy because it has the ability to describe long-run anomalous returns to shareholders, which is the process of creating persistent competitive advantage (Toms, 2010). Such returns can be attained by accessing resources, for example, monopoly control of a competitive heterogeneity (e.g. carbon strategy) or the creation of difficult to replicate resources.

Carbon risks come from two primary sources, the industry's emission nature and the implementation of stringent carbon regulations. These risks incur environment-related costs in terms of risk management, clean-up, or compliance. If a company commits potentially harmful activities (i.e. massive carbon emissions), its reputation may also be adversely affected (Nguyen, 2017). Currently, risk management is recognized as part of an organization's overall MCS. It is necessary to understand risk management and how risks can impact not only related control system features but also corporate performance. Specifically, if the business environment has significant uncertainty, there is a greater need to understand how a company determines, evaluates, and responds to possible emerging risks through its MCS. Carbon risk management encompasses the assessment of risks related to carbon emissions, which may cause companies to face issues coinciding with its positive or negative effects on business activities. Based on the RBV, to gain resource value, a company must investigate and assess risks and opportunities in their surrounding environment. Competitive advantage is identified by these competencies or capabilities to produce greater performance (Barney, 1991).

Some businesses see carbon accounting as an action to minimize risks, while others see it as a reputation builder that discloses a better image (Kamat, 2015). Therefore, a company must have a strategy to evade risks and grasp opportunities related to carbon emissions. Frequent communication with or by top management concerning carbon emission risk management and carbon strategy is considered a defining characteristic of interactive control systems (Simons, 1995). According to Kumarasiri (2016), accounting practices can provide valuable insights about the risks and opportunities of carbon emission mitigation, which would otherwise go unnoticed. The respondents in the author's study even stated that they had not thought about the opportunities available for them and their customers through carbon footprint reduction until they measured it. Accounting information further assures organizations that they have effective risk management as a good accounting system means the risks and opportunities of their operations are under control. As such, despite different motives behind using management accounting methods to handle climate change risks, managers have ultimately realized the evident benefits of accounting in managing emission performance (Kumarasiri, 2016). The adoption of management accounting and the selection of an appropriate strategy should therefore help organizations effectively manage exposure to changing risks while also leveraging opportunities to achieve organizational objectives.

Consistent with these arguments, Hartmann et al. (2013) stated that accounting practices play a positive role in managing climate change risks. Consequently, a carbon strategy that enables carbon risk management information to be captured by a carbon accounting system may positively impact a company's carbon performance and simultaneously restore environmental vitality for the wellbeing of the nation and society. Therefore, following the theoretical propositions of the RBV, the following hypothesis was proposed:

H_1: Carbon risk management positively influences the implementation of carbon accounting.

Given the close link between EMA and environmental performance, this study believes that an organization's carbon accounting or carbon accounting system (CAS) plays a significant role in improving its carbon performance. Research on the association between CAS and carbon performance remains scarce, especially in the Malaysian context. Tang and Luo's (2014) study is the only one thus far that has empirically examined the relationship between firms' CAS and carbon emission mitigation. Their findings confirmed a positive correlation between CAS and carbon mitigation elements. However, they did not pay attention to CAS features that collect and process for internal management needs financial and environmental data. The legitimacy theory, which says that an organization's conduct should represent the values and beliefs of the social paradigm in which it works, was used to support the association between carbon accounting and organisational performance in this study (Suchman, 1995). As a result, a firm would reveal information about its carbon emissions in order to justify its activities. This problem should be

explored in depth and researched, given the strategic importance of carbon accounting implementation in carbon-sensitive enterprises. As a result, the following hypothesis was established, based on the legitimacy theory:

H_2: The implementation of carbon accounting positively influences carbon performance.

Nowadays, companies find it essential to have an active, consistent, and continuously evolving environmental strategy, environmental information system, and Environmental Management Control System (EMCS). Carbon accounting has the same characteristics as an EMA system and is expected to capture and emphasize the carbon information of an organization. EMA has been the subject of a number of recent studies, all of which emphasise the significance of accounting while pursuing environmental management techniques (Schaltegger et al., 2013). The use of EMA in an organization leads to the existence of its environmental strategy, while the EMCS ensures the effective and efficient use of available resources to encourage environmental performance (Pondeville et al., 2013). Carbon-intensive firms are considered the most polluting firms, which exposes them to higher carbon risk (Nguyen, 2017). The application of carbon accounting or other accounting techniques related to carbon emission is a new exercise motivated by the need to manage reputational risk and financial risk imposed by increased energy costs and regulatory reporting requirements (Kumarasiri, 2016). Nguyen (2017) found that higher carbon risk worsens firm performance, wherein this effect is stronger when carbon regulations are stricter. Therefore, a better understanding of how companies respond to emergent risks related to carbon emission reduction through carbon accounting is critical for superior carbon performance that improves resource allocation and decision-making. Accordingly, supported by the RBV, the following hypothesis was proposed:

H_3: Carbon accounting mediates the relationship between carbon risk management and carbon performance.

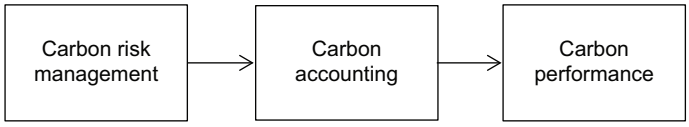
Based on the discussion above, the conceptual framework shown in Figure 1 was developed.

4. METHODOLOGY

4.1. Sample

All ISO 14001 Environmental Management System (EMS) certified companies in Malaysia (a total of 586 at the point of data collection) were included as the study population. Despite not mandatorily required to by Malaysian regulations, these companies have channelled substantial resources into certifying their EMS. The ISO 14001 certification is also considered an indication that the companies integrate environmental values into their business operations and minimize their liabilities (Ahmed et al., 2012).

Figure 1: Conceptual framework



This is because ISO 14001 does not only serve as a mere standard but also contributes to a company's success by complementing the established environmental protection system and reducing costs in the long term (Ong et al., 2015). Such an effort signals stakeholders of these firms' commitment to and assurance of environmental protection. As such, these companies are likely to be highly proactive in implementing environmental practices.

4.2. Questionnaire

Data was collected using a questionnaire sent to targeted companies via postal mail and, in some cases, via email. Each hardcopy questionnaire form was mailed with a cover letter and a stamped return envelope. Multiple phone calls were made to the respondents as a follow-up measure to increase the response rate and to persuade those who had not returned their questionnaire. A replacement questionnaire was provided to those who had missed the previous one.

4.3. Measurement Scales

The questionnaire comprised five sections; one solicited the companies' details while four measured the study variables using scales adopted from previous literature. The scales were adapted as follows: carbon risk management (6 items) was from Damert et al. (2017), carbon accounting (4 items) was from Solovida and Latan (2017) and Bahari et al. (2016), and carbon performance (11 items) was from Burritt et al. (2011) and Solovida and Latan (2017). All items were rated on a 5-point Likert scale ranging from "1-strongly disagree" to "5-strongly agree."

4.4. Response Rate

A total of 136 survey responses were collected from the 586 distributed questionnaires. This yielded a response rate of 23.2 percent, which is comparable to other firm-based survey studies in Malaysia (Eltayeb et al., 2011; Lee et al., 2013). Moreover, a sample size of 136 companies was deemed adequate for partial least squares structural equation modeling (PLS-SEM) analysis as it fell within the acceptable sample size range (Hair et al., 2017).

5. RESULTS

5.1. Demographic Profile

The demographic profile of the firms that took part in this survey is shown in Table 1. The bulk of the companies (67.7%, n = 92) were between the ages of 21 and 40. Small and medium-sized businesses were likewise the most prevalent, accounting for 69 percent (n = 69). Other sectors had the highest percentage (n = 31, 22.8 percent) of respondents from engineering, technology, transportation and automotive, finance, manufacturing, infrastructure, commercial, materials, consulting, operation and maintenance, authority, and government agencies among the industrial sectors studied. Among the respondent companies, 94 (69.1%) were locally owned, representing the majority.

5.2. Partial Least Squares Structural Equation Modeling (PLS-SEM) Analysis

The data analysis contained information from a total of 136 valid surveys. SmartPLS Version 3.2.3 is required for PLS-SEM analysis. To perform PLS-SEM analysis, SmartPLS Version 3.2.3 (Hair et al., 2016) was used to assess the measurement model and structural model.

5.3. Assessment of Measurement Model

As per Hair et al., (2016), before testing the hypotheses, the measuring methodology established the constructs' reliability and validity. Latent variable scores were subsequently used as indicators in the higher-order structural model analysis.

Table 2 shows the results of the constructs' internal consistency reliability and convergent validity. Average variance extracted (AVE) for all constructs ranged from 0.647 to 0.703, while composite reliability (CR) values ranged from 0.904 to 0.946 and Cronbach's alpha values ranged from 0.858 to 0.934. As the thresholds for AVE and reliability are 0.5 and 0.7 respectively, the constructs in this study demonstrated satisfactory convergent validity and internal consistency reliability.

The square root of each variable's AVE should be larger than the squared correlations between the variable and other variables to show discriminant validity (Chin, 1998; Fornell & Larcker, 1981). As shown in Table 3, the diagonal square roots of AVE were greater than the off-diagonal correlations. Therefore, discriminant validity was fulfilled in the study model.

5.4. Assessment of Structural Model

After evaluating the measurement model, the structural model was subsequently tested to confirm the study hypotheses. Since PLS-SEM does not generate inferential statistics on model fit and parameters, the bootstrapping procedure was carried out with 5000 resamples using the SmartPLS 3.2.3 software (Chin, 2010). Bootstrapping produces statistics on standard path coefficients, standard errors, and t-values, which allows the evaluation of the significance of each hypothesis (Hair et al., 2017). Table 4 presents the results of the significance of all the direct paths, which are discussed in-depth later in this paper.

The value of R^2 ranges from 0 to 1, where a higher value indicates greater and better predictive accuracy (Hair et al., 2014). Further, according to Hair et al. (2014), R^2 values of 0.25, 0.50, and 0.75 are interpreted as weak, moderate, and substantial, respectively. Table 5 shows that the R^2 values were 0.880 for carbon accounting and 0.850 for carbon performance, which exhibited substantial predictive accuracy.

According to Cohen (1988), the effect is considered large when f^2 is 0.35, medium when f^2 is 0.15, and small when f^2 is 0.03 (Cohen, 1988). From Table 6, it can be seen that carbon risk management had a small effect while carbon accounting had a medium effect on carbon performance.

Table 7 shows the Q^2 values for all the endogenous constructs, which establish that the model has predictive relevance, where Q^2 greater than zero are considered to have predictive relevance (Hair et al., 2016).

5.5. Assessment of Mediation

The significance of carbon accounting as a mediator between carbon risk management and carbon performance was determined through the complete bootstrapping procedure with 5,000 sub-samples (Hair et al., 2014). Table 8 shows the results of the mediation effect.

Table 1: Demographic profile

Description	Frequency	Percentage
n = 136		
Company age		
Below 20 years	20	14.7
Between 21 and 40 years	92	67.7
Over 40 years	24	17.6
Number of employees		
Below 200 (small and medium-size)	69	50.7
200 to 500 (large size)	31	22.8
Over 500 (larger)	36	26.5
Industrial sector		
Consumer products	20	14.7
Industrial products	34	25
Construction	21	15.4
Trade and services	3	2.2
Oil and gas	11	8.1
Plantation	5	3.7
Mining	2	1.5
Properties	2	1.5
Chemicals	3	2.2
Education	2	1.5
Healthcare	2	1.5
Others	31	22.8
Type of ownership		
Local	94	69.1
Foreign	6	4.4
Joint venture local and foreign	36	26.5

Table 2: Factor loadings, convergent validity, and reliability of research constructs

Construct	Item	Loading (λ)	AVE	Composite reliability	Cronbach's alpha (α)
Carbon risk management	CRM1	0.866	0.703	0.904	0.858
	CRM2	0.877			
	CRM3	0.854			
	CRM4	0.751			
Carbon accounting	CA1	0.897	0.686	0.946	0.934
	CA2	0.860			
	CA3	0.748			
	CA4	0.907			
	CA5	0.856			
	CA6	0.802			
	CA7	0.735			
	CA8	0.803			
Carbon performance	CP2	0.799	0.647	0.943	0.931
	CP4	0.724			
	CP5	0.788			
	CP6	0.763			
	CP7	0.742			
	CP8	0.731			
	CP9	0.907			
	CP10	0.882			
	CP11	0.880			

Table 3: Discriminant validity

No	Construct	CRM	CA	CP
1	Carbon Risk Management (CRM)	0.839		
2	Carbon Accounting (CA)	0.806	8.828	
3	Carbon Performance (CP)	0.814	0.715	0.805

Diagonals (italic) show the square roots of AVE. The rest are Pearson's correlation values

Table 4: Significance of direct paths

Hypothesis	Path	Standard beta (β)	Standard error ($\sigma\bar{x}$)	t-value	p-value	Result
H1	CRM>CA	0.123	0.043	2.846**	0.004	Significant
H2	CA>CP	0.751	0.054	13.856**	0.000	Significant

** significant at P<0.01; CRM: Carbon risk management, CA: Carbon accounting, CP: Carbon performance

Table 5: Coefficient of determination, R^2

Endogenous latent variable	R^2 value	Assessment
Carbon Accounting	0.880	Substantial
Carbon Performance	0.850	Substantial

Table 6: Effect size, f^2

Construct	CA	CP	Effect size (f^2)
CRM	0.041		Small
CA		0.771	Medium

CRM: Carbon risk management, CA: Carbon accounting, CP: Carbon performance

Table 7: Predictive relevance, Q^2

No	Construct	Q^2
1	Carbon Risk Management	0.499
2	Carbon Accounting	0.594
3	Carbon Performance	0.549

6. DISCUSSION

6.1. Carbon Risk Management and Carbon Accounting

The direct path result of carbon risk management and carbon accounting (CRM > CA) showed a significant positive relationship ($\beta = 0.123$, $p < 0.01$); thus, H1 was supported. As predicted, companies take more actions to mitigate risks associated with uncertainty, for example carbon emissions, when they perceive regulatory uncertainty as a risk to their organizations (Engau and Hoffmann, 2010). This finding is consistent with prior research, such as the work of Hartmann et al. (2013), that support the positive role of management accounting practices in managing risks from climate change. The adoption of carbon risk management could therefore help companies increase their competitive advantage, despite carbon risk management being time- and cost-consuming (Zhou et al., 2020). In fact, the assessment of carbon risk has been identified as the element of a well-functioning carbon management system (Tang and Luo, 2014). Carbon risk should be assessed, especially when risk materiality can affect business opportunities. As carbon risk materiality is consistent with the increasing popularity of risk assessment in today's business environment, it can be measured in terms of financial performance, environmental impact magnitude, stakeholder impact, business disruption and uncertainties, negative reputation, legal issues, and public health and safety. This study's finding suggests that based on the degree of risk materiality, it is important for companies to manage carbon risk via carbon accounting as a support system.

6.2. Carbon Accounting and Carbon Performance

The direct path result of carbon accounting and carbon performance (CA > CP) revealed that carbon accounting has a significant positive effect on carbon performance ($\beta = 0.751$, $p < 0.01$), thus supporting H2. This finding is consistent with the statement that the focal point of carbon accounting is the determination of carbon performance (Hashim et al., 2017). It implies that a firm's effort to implement carbon accounting at the organizational strategic level leads to superior carbon performance. Currently, CO_2 emission is threatening the environment and companies themselves, the latter of whom are exposed to risks of penalty or legal fines. Thus, when companies strategize their efforts to reduce CO_2 by employing carbon accounting as a designated technological tool, they are more likely to gain improved carbon performance. In other words, carbon performance is strengthened and improved through the benefits received from carbon accounting. Carbon accounting provides accurate CO_2 data by measuring and monitoring processes, which subsequently aids in achieving reduction targets and motivating better performance. Although the assessment of carbon performance can vary depending on firms' practices to reduce CO_2, assessing carbon performance shows that environmental considerations are taken seriously by firms. Enterprises that improve their carbon performance lower their industry's carbon emission index (CEI), encourage cleaner manufacturing, reduce their carbon footprint, and generate goodwill for companies that show CO2 reduction initiatives. The strong link between carbon accounting and carbon performance demonstrates that better carbon accounting promotes corporate carbon performance, which is critical for meeting the requirements of diverse stakeholders and creating transparency for those who want to compare corporate performance and efficiency in the long run.

6.3. The Mediating Effect of Carbon Accounting between Carbon Risk Management and Carbon Performance

The mediation result (CRM > CA > CP) reported that carbon accounting exerts a full mediating effect on the relationship between carbon risk management and carbon performance, which supported H3 ($\beta = 0.092$, $p < 0.01$). As such, carbon accounting potentially facilitates better carbon performance through risk assessment. In fact, researchers frequently evaluate a firm's carbon emission to assess its environmental performance or risk (Dixon-Fowler et al., 2013). Orlitzky et al. (2003) found that market-based measures reveal competitive advantage from reputational advantages of positive environmental performance, lowered risk perceptions, and stakeholder need fulfilment, whereas accounting measures are superior indicators of efficiency and organisational competencies. Though companies invested in carbon accounting are perceived as adding risk because this accounting form is still new and has relatively uncertain practicality, carbon accounting also has greater prospects for superior carbon performance when a firm correctly and proactively implements it. In turn, strong carbon performance reflects efficient organizational and managerial capabilities, which include a carbon risk management strategy and carbon accounting.

Table 8: Mediation result

Hypothesis	Path	Standard beta (β)	Standard error ($\sigma\bar{x}$)	t-value	p-value	Result
H3	CRM>CA>CP	0.092	0.034	2.686**	0.007	Significant

**Significant at P<0.01; CRM: Carbon risk management, CA: Carbon accounting, CP: Carbon performance.

7. CONCLUSION

Carbon risk management is critical to the successful implementation of carbon accounting, according to the findings. Similarly, there was a substantial positive association between carbon accounting and carbon performance. Carbon accounting also acted as a complete mediator in the interaction between carbon risk management and carbon performance. As a result, carbon accounting aids carbon risk management's operational function in increasing carbon performance. Carbon risk management promotes the adoption of carbon accounting, thus companies should proactively integrate carbon management in their organisational processes. As a result, firms with managers that are conscious of carbon reduction initiatives have superior carbon performance. This paper presents factual verification and a fundamental knowledge of carbon accounting in Malaysia, light of the results. It also provides information on management techniques, with a focus on ISO 14001 certified businesses and other businesses that use environmental management systems.

At present, thousands of corporations have joined coalitions and initiatives designed to monitor and transform their business practices towards more emission-conscious ways. Gradually, organizations seek ways to increase profits without destroying the environment, which makes both profitability and sustainability possible. Without aggressive transformative action to reduce carbon and greenhouse gas emissions, the world's temperature will continue rising, exposing millions of people to droughts and extreme poverty. For every fraction of a degree that the temperature increases, these problems will worsen substantially. Researchers and activists are struggling to find holistic solutions to climate change issues, especially carbon emissions, and to make world leaders take the climate threat seriously. Hopefully, actions will not be delayed anymore. Though it will be challenging for organizations, especially in Malaysia, to be sufficiently proactive in reducing carbon emissions, today's actions will define this era in the eyes of future generations. Therefore, rising to the challenge will promise a new and fundamentally healthier economy with unprecedented greater opportunities in the future.

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