ERIA Discussion Paper Series

No. 528

Policy Recommendation to Achieve a Carbon-Neutral Economy: The Case of Corporate Governance and Carbon Performance in Malaysia's Smart Cities

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July 2024

Abstract: *This study explores the role of corporate governance in carbon-intensive and non-carbon-intensive companies within Malaysian smart cities. The paper aims to understand the challenges and impacts of corporate governance on carbon and financial performance. In the first stage, carbon emissions data from 51 Bursa Malaysia-listed companies were analysed, revealing that corporate governance had no significant impact on carbon and financial performance. However, variations were noted in carbon-intensive industries. Liquidity emerged as a key factor positively affecting carbon performance, while firm size and market-to-book value were the main drivers of financial performance. In the second stage, a survey of 256 firms highlighted a high level of awareness regarding the significance of carbon reporting practices. Challenges included complexity regarding carbon reporting and knowledge limitations. The study advocates for the centralisation of carbon accounting standards, sharing best practices, and fostering of global collaboration to bolster effective climate action. These findings offer empirical evidence crucial for informing policymakers, companies, investors, and regulators alike. Future research could expand with larger samples, explore digital technology's role in smart cities, and compare carbon reporting practices globally.*

Keywords: Carbon performance, corporate governance, financial performance, energy, smart city, carbon neutral

JEL classification: F14, F40

1. Introduction

Since the early 2000s, the advancement of smart city development has garnered worldwide traction as a potential remedy to burgeoning urbanisation. The allure of enhancing quality of life and fostering sustainability has propelled the evolution of the smart city concept (Salman and Laouisset, 2020). Various perspectives define the essence of a smart city, encompassing environmental, technological and mobility, economic, governance, quality of life, and societal views (Youssef and Diab, 2021).

In 2019, the Malaysian government launched the Malaysia Smart City Framework (MSCF), which defines a smart city as one that 'uses ICT and technological advancement to address urban issues, including to improve quality of life, promote economic growth, develop a sustainable and safe environment and encourage efficient urban management practices' (, 2019). The MSCF consists of seven domains: smart economy, people, governance, mobility, environment, living, and digital infrastructure. The lack of appropriate governance arrangements for most cities appears to be the most serious obstacle to effective transformation into smart cities. The impact of the coronavirus disease (COVID-19) has exacerbated the challenges in this area, and Malaysian cities urgently need to establish new norms to address urban issues.

The essence of smart cities is to deliver better quality of life and ensure a sustainable environment, suggesting the necessity to rebuild cities sustainably using environmental, social, and governance (ESG) principles. Sustainability is one of the strategic goals of smart cities, as reflected in the establishment of the 11th United Nations Sustainable Development Goal (SDG), which aims to make cities inclusive, safe, resilient, and sustainable (United Nations, 2018). SDG 11 stands as a pivotal force in propelling innovation within smart cities and fostering a sustainable future. Firms operating within smart cities must adapt to this goal by intensifying their ESG development effort (Buallay, El Khoury, and Hamdan, 2021).

The literature suggests that collaboration with the private sector is essential to sustainability solutions. Corporate governance and its necessary changes are important to positively influence ESG development through governance practices and market presence. Currently, most of the literature related to Malaysia focuses on corporate governance and carbon performance in environmentally sensitive and non-environmentally sensitive industries, but not specifically in carbon-intensive and non-carbon-intensive industries, particularly for those located in the smart cities. Given that carbon-intensive industries produce a significant amount of carbon dioxide (CO_2), which is a major cause of climate change, conducting a

comparative study of carbon-intensive and non-carbon-intensive industries in smart cities is of great significance for achieving a carbon-neutral economy.

A review of the literature suggests that firms in carbon-intensive industries may respond differently to climate change mitigation than those in non-carbon-intensive industries. Moreover, the effectiveness of corporate governance mechanisms in reducing emissions may also vary across these two industries. Recent evidence indicates that firms in non-carbon-intensive industries are more actively responding to the development of a low-carbon economy, are more proactive in their carbon disclosure, and are more confident in their ability to reduce carbon emissions. In addition to demonstrating better carbon performance compared with carbon-intensive industries (Lu, Zhu, and Zhang, 2021), non-carbon-intensive industries highlight the more significant role played by corporate governance (Liao, Luo, and Tang, 2015).

Based on an extensive stocktaking of the literature, the research topic exploring the relationship between corporate governance, carbon performance, and financial consequences has emerged as an innovative subject within business research. This topic has sparked debate amongst researchers, regulators, and practitioners in the field of environmental practices. The significance of climate change policies has been underscored by the Paris Agreement, emphasising the business implications involved. While carbon performance measurement and carbon disclosure remain predominantly voluntary in many countries and businesses worldwide, the discretionary nature of managerial transparency regarding carbon performance and its financial consequences has become increasingly crucial. While the existing studies focused on developed countries are reaching a plateau, little attention has been devoted to developing countries. Conducting studies in developing countries is of paramount importance, as these nations bear a substantial responsibility for carbon emissions and contribute significantly to global warming. Hence, this study aims to shed light on new evidence investigating how corporate governance practices could influence the carbon performance and financial consequences of firms in carbon-intensive and non-carbon-intensive industries in developing countries, particularly Malaysia. The specific objectives of the study include the following:

(i) To investigate whether corporate governance plays a different role in companies that belong to a carbon-intensive industry versus a non-carbon-intensive industry.

(ii) To examine the challenges of corporate governance related to carbon and financial performance amongst firms.

(iii) To propose policy recommendations that could facilitate Malaysia's transition towards decarbonisation.

2. Literature Review

2.1. Climate Policies and Sustainability Reporting Practices

In recent years, urbanisation and global warming have emerged as paramount concerns within the realm of climate change, demanding significant attention. In Malaysia, urbanisation has outpaced rural development, with a rate of 50.7% surpassing the rural rate of 49.3% since 1991. Over the past 5 decades, this urbanisation rate has tripled, soaring from 28.4% in 1970 to 77.7% in 2021 (Department of Statistics Malaysia, 2022). The data indicate a growing urban population, which is expected to surge by 80% in 2030 (Economic Planning Unit, 2020). This rapid pace of urbanisation in certain cities has resulted in heightened carbon emissions. Consequently, the government is advocating for and promoting the development of smart cities to address the challenges associated with excessive urbanisation, while committing to enhance quality of life and foster a sustainable future.

Malaysia has introduced environmental strategies to decarbonise the environment, and regulators have accelerated the implementation of environmental policies to limit greenhouse gas (GHG) emissions and promote carbon reporting (Bahari, Abdillah, and Alrazi, 2023). The growing awareness of climate change has led to a surge in the need for emissions monitoring and carbon reporting within companies. As a result, an increasing number of firms are extensively reporting on their carbon performance, leading to a steady rise in the demand for corporate information (Chariri, Januarti, and Yuyetta, 2018).

Malaysia has also developed a series of policies and plans to ensure that climate-resilient development is able to fulfil the national agenda of sustainability: the National Policy on the Environment (2002), National Policy on Climate Change (2009), National Green Technology Policy (2009), National Renewable Energy Policy and Action Plan (2010), Renewable Energy Act (2011), National Solid Waste Management Policy (2016), and National Policy on Biological Diversity 2016–2025 (2016). Malaysia's leaders have also made ambitious commitments to the United Nations Framework Convention on Climate Change (UNFCCC) and have increased their mitigation ambition, with an unconditional target to reduce carbon intensity against gross domestic product (GDP) by 45% by 2030 compared with 2005 levels. Additionally, Malaysia aims to achieve net zero emissions as early as 2050. Achieving this target necessitates substantial scaling of investments in the energy transition, estimated at up

to US$415 billion, alongside the implementation of carbon management solutions, particularly in challenging sectors (International Renewable Energy Agency, 2023).

Malaysia's dedication to the UNFCCC is underscored by its provision of comprehensive data and information regarding mitigation responses aimed at curbing carbon emissions, thus contributing to the global effort to mitigate climate change (MESTECC, 2018). In achieving low-carbon outcomes, city leaders will also need to engage in a comprehensive array of mitigation actions. All key sectors under city management will have important roles, including land and spatial development, urban energy use for industry, buildings, transport, and municipal services. Furthermore, the development of the Low Carbon Cities Framework in Malaysia requires active promotion and use of green technologies and sustainable methods in the development and operation of a city. The Low Carbon Cities Framework was formulated by the government in 2011 and serves as a guide for developers, local councils, town planners, or non-governmental organisations (NGOs) to reduce the level of carbon emissions in cities (Ministry of Environment and Water, 2021). Some notable smart cities in Malaysia are Cyberjaya, Putrajaya, Iskandar Malaysia, Kuala Lumpur, Malacca, and Kota Kinabalu. Putrajaya, for instance, incorporates smart city principles into its design and operations, with an emphasis on efficient energy management, smart transportation, digital governance, and sustainable development. In a similar vein, it aspires to become a carbon-free city and is taking the first steps towards creating a smart electricity grid.

In late 2022, Malaysia established the National Energy Council, a new agency responsible for steering agendas and strategies outlined in the National Energy Policy (2022–2040). The council's mandate includes a crucial focus on enhancing nationwide carbon emissions reporting. Furthermore, Malaysia is developing its own long-term Low Emissions and Development Strategies (LT-LEDS). To further promote the adoption of renewables, the government introduced the Corporate Green Power Programme in late 2022, where the private sector can undertake a corporate power purchase agreement with a solar photovoltaic producer, fostering the uptake of renewables (Energy Commission, 2022: 3). This program encouraged trading of renewable energy certificate to effectively fulfil the firm's ESG commitments (International Renewable Energy Agency, 2023).

The development of sustainability reporting in Malaysia has been progressing over the years. In 2000, the Securities Commission Malaysia introduced the Malaysian Code on Corporate Governance (MCCG), which plays a proactive role in advocating for the integration of sustainability considerations into corporate strategy, governance, and decision-making

(Securities Commission Malaysia, 2021). The MCCG encourages companies to assess their operations, establish science-based emissions reduction targets, and strive for cleaner and more sustainable growth. The MCCG embodies globally recognised principles and practices of corporate governance that surpass the minimum requirements set by statutes, regulations, or those prescribed by Bursa Malaysia. Building on this commitment, Bursa Malaysia launched its Sustainability Reporting Initiative in 2015, mandating listed companies to produce an annual sustainability statement and adopt sustainability reporting practices. The initiative aims to improve transparency, accountability, and the integration of sustainability considerations into business strategies. In 2016, Bursa Malaysia took another step forward by introducing a mandatory sustainability framework for all publicly listed companies in their corporate reporting. This framework further supports the integration of sustainability considerations into corporate strategies. To facilitate this integration, Bursa Malaysia collaborates with the Global Reporting Initiative, organising workshops and training programmes on sustainability reporting. These collaborative efforts contribute to building capacity and knowledge about sustainability reporting practices amongst companies. The Malaysian Institute of Corporate Governance also provides training and guidance on ESG practices for directors and corporate leaders. Additionally, on 9 December 2022, Bursa Malaysia launched the Bursa Carbon Exchange, designed as a voluntary carbon market. Its purpose is to facilitate companies in trading voluntary carbon credits derived from environmentally sustainable projects and solutions. This initiative allows business to offset their carbon emissions footprint and align with climate goals. The inaugural auction is scheduled to commence in March 2023, encompassing a range of permissible projects including nature- and technology-based solutions that contribute to the avoidance, reduction, or removal of GHG emissions (Bursa Malaysia and Malaysian Green Technology and Climate Change Corporation, 2023: 47).

The effects of sustainability reporting are seen by companies as one of the means to introduce and reinforce sustainability principles throughout an organisation. Sustainability reporting is proven to have an influence on companies' performance and enhance their efficiency (Adams and McNicholas, 2007). Improving the sustainability performance and reporting of a firm would also raise the share price by increasing revenue and net profit, thus inspiring better financial performance and assuring shareholders of the safety of their investments (Aggarwal, 2013; Khaveh et al., 2012). According to the Association of Chartered Certified Accountants (ACCA, 2010), even though Malaysia scored the highest in the developing countries category in Southeast Asia, the percentage of companies that reported on

sustainability is low compared with the number of businesses in the country (Kasbun, Teh, and Ong, 2016). The low percentage of reporting can be attributed to various factors such as the high reporting cost, difficulty in measuring performance, difficulty in encouraging proactive reporting amongst companies, lack of awareness and companies' assumptions regarding the additional costs and resources required for reporting, poorly performing companies, and inconsistency in reporting.

Although sustainable reporting is gaining traction in Malaysia, there is still room for progress in terms of widespread adoption and standardisation. Ongoing efforts are focused on enhancing reporting quality, ensuring data comparability, and further integrating sustainability considerations into corporate strategies. It is expected that carbon management and sustainable reporting will continue to develop and become more integral parts of business practices in the coming years.

2.2. Corporate Governance, Carbon Performance, and Financial Performance

As cities consume 78% of the world's energy and produce more than 60% of the world's GHG emissions (United Nations, 2022), the impact of cities on GHG emissions becomes increasingly evident. Consequently, cities have become a primary focus in the global effort to mitigate climate change (Mia, Hazelton, and Guthrie, 2019). To align with the decreasing GHG emissions targets set by numerous countries, it is crucial for cities to minimise their energy usage. Since firms are amongst the biggest polluters of CO_2 emissions, they play an essential role in tackling climate change and global warming. Reducing the carbon footprint of companies is a big step for cities to take to align with the current policies promoted at the national and international levels. Hence, both cities and firms are now being motivated by NGOs, government organisations, and many other environmental and social policy and planning activists to disclose their environmental impact through sustainability reporting (Luo et al., 2017).

Reductions in urban energy use, along with urban GHG and air pollution emissions, are important aims of smart cities (Wang and Moriarty, 2019). Although there is potential for a significant reduction in energy use by cities, it will not be realised unless supporting policies are in place (Wang and Moriarty, 2019). Governance structures play a pivotal role in the successful development of a smart city. They serve as the main determinant for ensuring effective processes and controls over the business model built around the smart city, encompassing the integration of various utilities to create value (Ooms et al., 2020). This integration requires the active involvement of diverse agencies and stakeholders, including the

local government, other (higher-level) governments, private organisations, knowledge institutes, businesses, and citizens (Noori, Hoppe, and de Jong, 2020). Most importantly, the role of governance deals with intending to comply with rules that manage the proper functioning of smart cities (De Guimarães et al., 2020). In the context of smart cities, smart governance becomes essential, as it enhances decision-making processes and facilitates the implementation of improvements in the daily lives of cities (De Guimarães et al., 2020). By leveraging technology, creativity, and viable business models, smart governance enables cities to integrate innovative solutions effectively (Noori et al., 2020).

The need for eco-friendly corporate strategies has become crucial to tackling the challenges of environmental pollution. As such, initiatives to lower CO_2 emissions should be embodied within the city and the firm's environmental sustainability agenda. Low-carbon goals may be met with effective coordination at all government and non-governmental levels amongst varied national bodies, high-level subnational agencies, and local governments (Dali, Sharifi, and Adnan, 2022). Specific targets have been outlined to lower GHG emissions in Malaysia by strengthening institutional and governance structures (Dali, Sharifi, and Adnan, 2022). Engelbert, van Zoonen, and Hirzalla (2019) highlighted the relevance of the role of citizens in the development of smart cities, emphasising their active participation in the governance process. This recognition is complemented by Sancino and Hudson (2020), who emphasised the importance of leadership in investigating smart cities to understand their emerging direction, meaning, and followership for informing policy and practice. Jackson and Parry (2018) proposed a comprehensive framework for examining leadership in smart cities, encompassing six lenses: place, purpose, person, position, process, and performance. However, despite the significance of leadership, there is a dearth of research on how it is being exercised within smart cities (Sancino and Hudson, 2020). To describe a smart city, the MCCG (2021) is considered a valuable framework. It not only emphasises the importance of board leadership and effectiveness but also highlights ongoing engagement and communication with stakeholders as crucial for building trust and understanding amongst cities, companies, and their stakeholders. Corporate governance, both at the city and corporate level, is a critical sustainability mechanism for firms, and strengthening corporate governance mechanisms is recognised as a strategy for achieving decarbonisation targets (Oyewo, 2023).

At the corporate level, corporate governance plays a major role in shaping the decision-making process and driving corporate environmental and sustainability management. The classical definition of corporate governance provided by the MCCG (2021) guides our study,

defining it as the process and structure used to direct and manage the business and affairs of a firm to promote business prosperity, corporate accountability, and long-term shareholder value while considering the interests of other stakeholders. The principles of ethical behaviour, accountability, transparency, and sustainability form the pillars of corporate governance, which are crucial for the effective governance of companies and the stewardship of investors' capital. Firms that embrace these principles are more likely to generate long-term value compared with those that lack them (MCCG, 2021).

Previous studies have indicated that corporate governance has a significant influence on the adoption of active environmental policies. Corporate governance leads to improved corporate social responsibility (CSR) concerning carbon performance (Luo and Tang, 2021). Although the response to climate change is a complex decision that entails a cost–benefit trade-off, it can be expected that, if good corporate governance means adequate representation of a broader range of stakeholders and if a board of directors is accountable to all stakeholders (including shareholders), a net positive impact of corporate governance on carbon performance can be observed (Luo and Tang, 2021).

According to Xia and Cai (2023), strong corporate environmental awareness promotes pro-environmental activities. Firms with good corporate governance demonstrate a stakeholder and long-term orientation that encourages environmental action and balances financial and sustainability goals, even with limited resources. As a result, these firms tend to enhance their green capacity, leading to better carbon performance (Luo and Tang, 2021). Additionally, firms with good corporate governance are more likely to be socially responsible, and their managers prioritise reducing emissions to align with public expectations, ensuring the justification of their continued operations. Luo and Tang (2021) further suggested that firms with higher-quality corporate governance achieve superior carbon reductions compared with both their industry peers and their own performance in the previous year. Directors of these firms wield significant influence in corporate governance, overseeing carbon performance management and actively engaging in decision-making processes. They are expected to effectively supervise the management team, displaying proactive involvement in carbon management initiatives to enhance the firm's long-term value (Akram, Abrar-ul-Haq, and Raza, 2018; Ong et al., 2021). As the central decision-making body, corporate boards are responsible for formulating and implementing environmental strategies, which require proactive enforcement (Ortiz-de-Mandojana, Aguilera-Caracuel, and Morales-Raya, 2016). Elsayih, Datt, and Tang (2021) supported this notion by stating that factors such as corporate board meetings, board

independence, board gender diversity, and the presence of an environmental committee can contribute to improved carbon performance in firms.

A firm with a strong corporate governance system is highly attractive to the market (Hong and Linh, 2023). Velte, Stawinoga, and Lueg (2020) emphasised the importance of implementing an appropriate corporate governance system to combat greenwashing, manage information overload, and enhance a firm's reputation. Demonstrating robust board oversight of climate change issues signifies a firm's commitment to addressing environmental concerns, leading to an improved reputation and credibility amongst stakeholders (Palea and Drogo, 2020). Board diversity is a significant corporate governance mechanism that positively impacts overall firm performance (Farooq, Noor, and Ali, 2022; Konadu et al., 2022). The board's role is to effectively utilise firm resources and develop business strategies, and increasing the number of board members can enhance the board's capacity and performance and create value for the firm (Toukabri and Jilani, 2022).

The carbon performance of companies is a crucial aspect of their operational performance, with significant financial implications such as reduced risk and changes in financial outcomes (Velte, Stawinoga, and Lueg, 2020). Efficient management of carbon emissions by companies can shape market expectations for their long-term performance, as reflected in market valuations (Trinks, Mulder, and Scholtens, 2020). Investors may assign a higher value to carbon-efficient firms based on demonstrated resource efficiency, leading to anticipated higher future cash flows. Additionally, these firms are often perceived as having lower risk, resulting in investors applying a lower discount rate when valuing their future cash flows (Trinks, Mulder, and Scholtens, 2020). Stakeholders also tend to reward firms with sustained carbon performance (Velte, Stawinoga, and Lueg, 2020). Firms that effectively reduce their carbon footprint to meet customer expectations can expect sustained or increased revenues from existing and potential customers (Lemma et al., 2019). By expanding their carbon-related activities and procedures, these firms demonstrate their innovative capacity in environmental aspects, which can reduce risk premiums and improve financial outcomes (Velte, Stawinoga, and Lueg, 2020).

2.3. Stocktaking of Bibliometric Analyses and Systematic Review

In the current study, 437 papers are collected and reviewed to observe, select, classify, and understand the carbon performance attributes in all economies around the world. The papers related to corporate governance, carbon performance, and financial performance were collected from the Scopus database from 1990 to 2022 using the bibliometric method. This

study selected and reviewed 159 Scopus-indexed journals based on bibliometric analyses of authors' citation analysis, papers' co-citation analysis, bibliometric references' co-citation analysis, journals' co-citation analysis, co-occurrence keyword cartography analysis, trend and evolution analyses of corporate disclosure publications over the years, and qualitative content analysis.

Throughout the stocktaking period, the study observed that there had been significant interest in the subject, as demonstrated by the increasing number of publications and proliferation of authors from around the world. An increasing number of researchers have studied corporate governance-related determinants and carbon performance to analyse financial consequences. Unsurprisingly, early articles focus on the United Kingdom, United States, Australia, and Italy, given that these countries are the global leaders in sustainable development agendas and corporate governance systems. As the role of corporate governance and environmental and social responsibility in companies become important topics of the ESG era towards the achievement of the SDGs, the focus on carbon performance in these countries has been increasing. As a result, since 2015, when the SDGs were adopted, prominent universities such as Leuphana University Lüneburg in Germany and Brno University of Technology in the Czech Republic have become significant contributors to the literature. Interestingly, Asian researchers, especially those from Universiti Teknologi MARA in Malaysia, appear to be heavily involved in this topic and contribute to and advance it in novel and intriguing areas, along with those from developed countries.

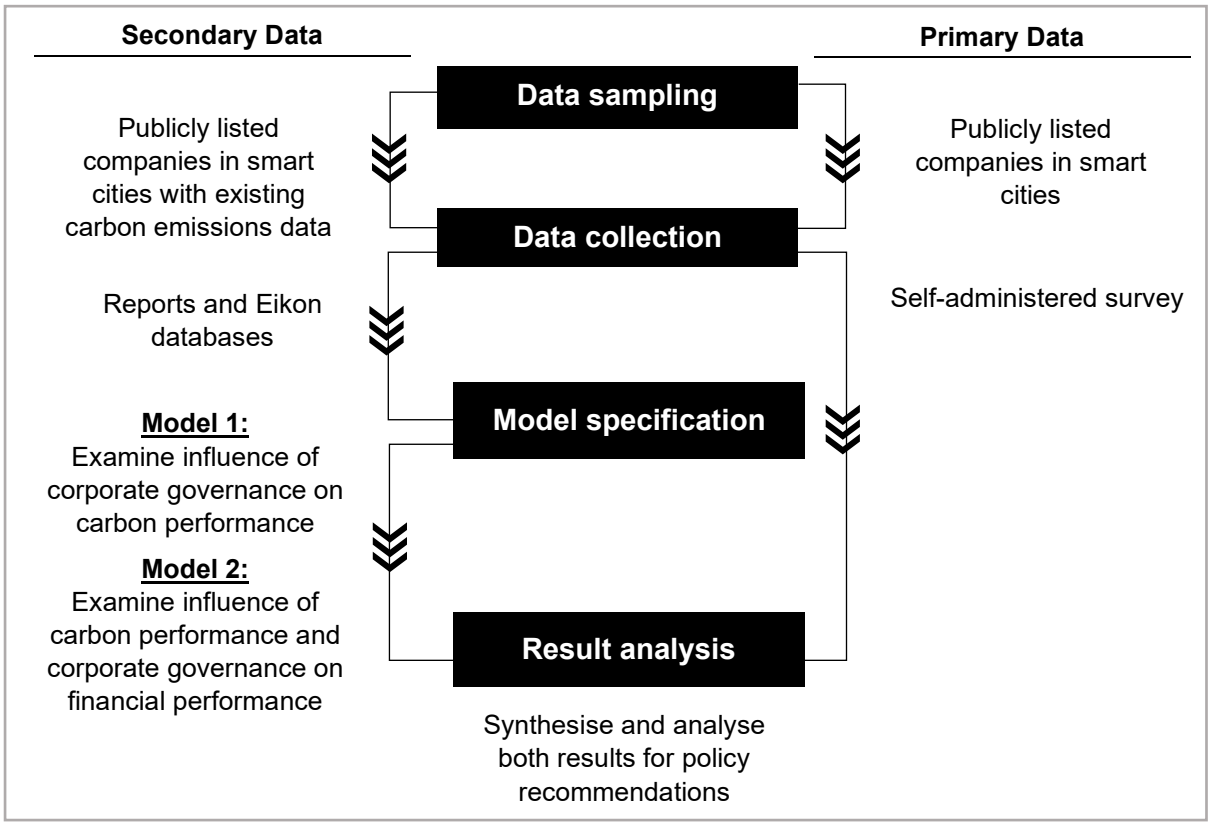
The most cited articles in corporate governance appear to be those that discuss the context of carbon performance and ESG responsibilities for developed countries. The significant number of citations for these papers demonstrates that researchers from multiple disciplines, i.e. business strategy, finance and accounting, operational engineering strategy, environmental management, policy studies, sustainability, etc., are strongly interested in corporate governance. This stocktaking exercise provides a record of the accomplishments of recent studies, showing that corporate governance and carbon performance have high relevance for firms and have financial consequences. The study finds that firms from developed countries might respond differently to climate change mitigation than those in developing countries. Moreover, the overarching corporate governance mechanisms might also vary in carbon-intensive versus non-carbon-intensive industries or developed versus developing countries due to regional complexity. This study highlights the importance of corporate governance, which affects carbon performance and the financial performance of a firm's business. This field has

been acknowledged as leading research in developed countries. Much research from developing countries' perspectives should be conducted in this field to communicate their climate change commitments and activities, as most of the existing research has focused on the impact of carbon performance and financial performance in developed countries.

3. Methodology

This section provides a detailed description of the methodology and steps employed in the quantitative and qualitative approaches applied in this study. Several approaches are used to meet the aim of this study. In general, it is a hybrid of primary and secondary data analysis methods. The data collection process took place in two stages. First, data from Eikon DataStream, annual reports, sustainability reports, and corporate governance reports were analysed to identify practices adopted by firms in smart cities regarding corporate governance and to examine their association with carbon and financial performance. Second, the primary data approach was conducted using the data gathered from the questionnaire design. The detailed methodology steps are illustrated in Figure 1.

Figure 1: Research Methodology Process



Source: Authors.

3.1. Data and Sample

3.1.1. Primary data

The study population comprises Malaysian publicly listed companies that operate within the smart cities of Kuala Lumpur, Putrajaya, Melaka, and Johor. Chen et al. (2021) stated that the combination of accelerated urban population growth and economic development poses a significant environmental challenge. Cities are the engines for world economic activities that consume massive amounts of energy and emit undesired amounts of GHG (Dali, Sharifi, and Adnan, 2022). Consequently, it is believed that cities contribute to the propagation of CO_2 emissions. Therefore, it is crucial for cities to take action to reduce GHG emissions, and smart cities can play a pivotal role in fostering sustainable, low-carbon urban development for the future. Using the Bursa Malaysia firm list as of 31 December 2022, a total of 293 companies operating within the smart cities were selected as the sample. Following Orazalin, Ntim, and Malagila (2023), financial service companies were excluded from the sample due to their distinct accounting requirements, governance systems, business operations, and regulatory frameworks for environmental pollution. Following the removal of 40 entries corresponding to financial firms from the list, the remaining count comprised 253 non-financial firms.

3.1.2. Secondary data

For secondary data collection, we filtered the remaining firms (253 non-financial firms) to include only those with the necessary carbon emissions data, resulting in 51 observations for 2021. The sample is further classified into carbon-intensive and non-carbon-intensive industries following the work of Abd Rahman, Abdul Rasid, and Basiruddin (2019). Table 1 presents the finalised sample for the study.

Table 1: Study Sample

City	Final Sample	Carbon-intensive Industries	Non-carbon-intensive Industries
Kuala Lumpur	48	27	21
Putrajaya	1	0	1
Melaka	1	0	1
Johor	1	0	1
Total	**51**	**27**	**24**

Source: Authors.

3.2. Data Collection

3.2.1. Phase one data collection

In the current study, carbon emissions and corporate governance data for 2021 were obtained from the content analysis of annual reports, sustainability reports, and corporate governance reports. The utilisation of these reports reflects the universe of information publicly available to investors (Zhang and Lucey, 2022). Financial data were obtained from Eikon databases (Thomson Reuters). The exclusion and inclusion of data is described in section 3.1.2.

3.2.2. Phase two data collection

Phase two of the data collection centres on capturing the perceptions of firms regarding carbon reporting practices. The primary data for this phase were gathered through a self-administered survey. The respondents were contacted based on their work scope related to sustainability governance (e.g. sustainability officer, executive, human resources manager, and director). Once the respondents agreed to participate, the questionnaire link was sent to their email. SPSS version 29.0 was used to analyse the quantitative data in this study. The first part of the questionnaire was designed to capture demographic information about the respondents' firm in terms of (i) location, (ii) size, (iii) type of industry, (iv) year of incorporation, and (v) ownership structure. The second part of the questionnaire assessed the level of awareness, best practices, challenges, and future initiatives of the respondents on the carbon reporting practices of firms in smart cities (Kuala Lumpur, Melaka, Johor, and Putrajaya). The responses were recorded using a 5-point Likert scale, with scores ranging from 1 (strongly disagree) to 5 (strongly agree). The detailed instruments collected from the survey can be found in Appendix A.

3.3. Model Specification

As described in Figure 1, the study involved two models. Model 1 focuses on examining the influence of corporate governance on carbon performance, while Model 2 explores the influence of carbon performance and corporate governance on financial performance. The specifications of Models 1 and 2 are described in Equations (1) and (2):

Model 1:

$$GHG = \beta_0 + \beta_1 CGQ + \beta_2 SIZE + \beta_3 ROA + \beta_4 LEV + \beta_5 MTB + \beta_6 PPE + \beta_7 GROWTH + \beta_8 CASH + e \quad (1)$$

Model 2:

$$TQ = \beta_0 + \beta_1 GHG + \beta_2 CGQ + \beta_3 SIZE + \beta_4 ROA + \beta_5 LEV + \beta_6 PPE + \beta_7 GROWTH + \beta_8 CASH + \beta_9 MTB + e \quad (2)$$

Where,

GHG	=	carbon performance measured by natural logarithm of total GHG emissions reported by firms
TQ	=	financial performance measured by natural logarithm of Tobin's Q
CGQ	=	corporate governance quality
SIZE	=	natural logarithm of a firm's total assets
ROA	=	firm profitability measured by return on assets
LEV	=	financial leverage measured by total debt divided by total assets
MTB	=	market-to-book ratio of equity
PPE	=	tangible assets measured by the sum of property, plant, and equipment divided by total assets
GROWTH	=	growth opportunities at 3-year annual sales growth in net sales, calculated as the current year's revenues divided by the revenues of the four preceding years, minus 1
CASH	=	liquidity measured by the ratio of cash and cash equivalents divided by current liabilities
e	=	error term

3.3.1. Dependence variable: carbon performance (Model 1) and financial performance (Model 2)

Carbon performance was measured using the total GHG emissions reported in the annual reports of the firms. In line with Baboukardos (2017) and Konadu et al. (2022), we use the natural logarithm of the reported amount of GHG emissions as a proxy for the carbon performance of a firm. The GHG emissions rate has a negative polarity, with a lower carbon emissions rate connoting better carbon performance (Moussa et al., 2020).

Financial performance was measured using Tobin's Q (*TQ*). *TQ* is the most widely used indicator of firm value. It is a market-based performance measure and is considered a representative measure of financial performance when assessing pollution protection. It effectively captures the long-term value of certain environmental activities (Endrikat, Guenther, and Hoppe, 2014; Nekhili et al., 2017) and indicates the market sensitivity to a firm's decision regarding the environment (Lee, Min, and Yook, 2015). *TQ* is calculated as the ratio of the market value of the shareholders' equity (the firm's share price × number of common stock outstanding) plus the book value of liabilities by the book value of total assets. A *TQ* ratio greater than 1.0 signifies that a firm's value surpasses the cost of its assets, prompting increased investment. Conversely, a *TQ* ratio below 1.0 indicates that the market value falls short of the recorded value of the firm's assets, thereby dissuading firms from making further investment (Campbell and Mínguez-Vera, 2008).

3.3.2. Independence variable: corporate governance quality

This study focuses on overall corporate governance quality rather than individual corporate governance elements. The argument is that corporate governance operates as a cohesive system of mechanisms rather than individual provisions (Solomon, 2020). The effects of individual corporate governance elements may not present a complete picture of the corporate governance system because some elements may have positive effects while others may work against any favourable outcome for carbon performance (Luo and Tang, 2021).

This study developed the comprehensive Malaysian Corporate Governance Index (MCGI), which assesses the quality of corporate governance practices in firms. The MCGI is constructed based on key corporate governance mechanisms outlined in the MCCG (2021). It specifies the number of governance requirements aligned with the principles and best practices set out in the MCCG (2021). To minimise measurement errors and bias, this study collected data on 46 corporate governance mechanisms, encompassing all the provisions recommended

by the MCCG. As indicated in Table 2, the MCGI consists of three sub-indices: board leadership and effectiveness, effective audit and risk management, and integrity in corporate reporting and meaningful relationships with stakeholders.

Table 2: Elements of the MCGI

Element	Number of Elements
Board leadership and effectiveness	
Board responsibilities	14
Board composition	11
Remuneration	4
Effective audit and risk management	
Audit committee	5
Risk management and internal control framework	4
Integrity in corporate reporting and meaningful relationships with stakeholders	
Engagement with stakeholders	2
Conduct of general meetings	6
Total CGQ elements	**46**

CGQ = corporate governance quality, MCGI = Malaysian Corporate Governance Index.
Source: Authors' calculation based on key corporate governance mechanisms outlined in MCCG (2021).

Table 2 highlights the emphasis placed by the MCCG on board responsibilities and board composition. Regarding 'board responsibilities' mechanisms, examples encompass a range of elements, including the establishment of strategic aims by the board, the defined responsibilities of the chair, and the clear separation of roles between the chair and CEO. In terms of 'board composition', examples encompass various aspects such as the composition of numeration committees, gender composition, and the annual evaluation of the board's effectiveness.

This study assigns equal weight to each corporate governance element, with a score of 1 or 0 based on the firm's compliance during each year/observation period. The score is subsequently calculated as a percentage, representing the proportion of the index score in relation to the overall range of scores. A higher MCGI score signifies a commendable level of corporate governance quality, as it reflects the collective performance of all the elements. This study adheres to the criterion of Tanjung (2023) for high corporate compliance, where a high

score is achieved when the index score is equal to or above the fourth quartile of governance index scores.

3.3.3. Control variable

As pointed out by Xia and Chai (2023), the association between carbon performance and financial performance may depend on firm-specific factors. Seven firm-level variables that affect carbon and financial performance were included as control variables, notably firm size (*SIZE*), firm profitability (*ROA*), financial leverage (*LEV*), market-to-book ratio (*MTB*), tangible assets (*PPE*), growth opportunities (*GROWTH*), and liquidity (*CASH*). These variables are constantly found to be related to carbon performance in previous studies (Luo and Tang, 2021).

4. Findings

4.1. Descriptive Analysis

Table 3 presents the descriptive statistics of the variables used in this study for 2021. The mean carbon performance in the sample is 11.63 million tonnes of GHG emissions.

Table 3: Descriptive Statistics

Variable	Minimum	Maximum	Mean	Std. dev.
GHG	-4.04	26.46	11.64	5.77
TQ	-2.22	3.67	0.27	0.83
CGQ	72.00	98.00	85.37	6.10
SIZE	18.20	25.20	20.08	1.83
ROA	0.00	1.00	0.04	0.12
LEV	-7.49	0.64	-1.76	1.42
MTB	-3.53	3.96	0.53	1.74
PPE	0.00	1.00	0.34	0.24
GROWTH	-1.00	2.00	-.69	0.44
CASH	-7.49	0.64	-1.76	1.42

Source: Authors' calculation based on the data compilation of selected Corporate Governance Report listed in Bursa Malaysia.

Regarding corporate governance quality (*CGQ*), the scores of firms located in smart cities range from 72% to 98%, with a mean of 85.37%. Given that the mean score for *CGQ* is below the fourth quartile of governance index scores, which stands at 89.13%, it suggests that companies operating in smart cities exhibit lower levels of corporate governance practices (Tanjung, 2023). The detailed score of *CGQ* elements of the companies is reflected in Table 4, which is highest for board responsibilities (13.21%), followed by board composition (8.06%) and conduct of general meetings (5.41%).

Table 4: Descriptive Statistics of Corporate Governance Quality Elements

CGQ element	Minimum	Maximum	Mean	Std. dev.
Board responsibilities	9.00	14.00	13.22	1.08
Board composition	5.00	11.00	8.06	1.41
Remuneration	1.00	4.00	2.96	0.53
Audit committee	3.00	5.00	4.35	0.63
Risk management and internal control framework	3.00	4.00	3.65	0.48
Engagement with stakeholders	1.00	2.00	1.47	0.50
Conduct of general meetings	4.00	6.00	5.41	0.61
CGQ	72.00	98.00	85.37	6.10

CGQ = corporate governance quality.
Source: Authors' calculation based on the data compilation of selected Corporate Governance Report listed in Bursa Malaysia.

Moreover, the mean firm size (*SIZE*), which is measured by total assets, is RM20.08 billion, with a minimum of RM18.20 billion and a maximum of RM25.20 billion. The mean of financial leverage (*LEV*) is –1.76%, with a range of –7.49% to 0.64%, suggesting that most firms have an operating cap rate that is lower than the interest rate of their debt. In addition, the mean value for the *MTB* is 0.53 (which is less than 1), suggesting that investors are valuing the firm lower than its stated book value. Regarding tangible assets (*PPE*), the mean value of 0.34 (which is less than 1) indicates that the firm's tangible assets are not fully utilised during the period of investigation.

4.2. Correlation Matrix

Table 5 exhibits the correlation between corporate governance, carbon emissions, financial performance, and other control variables. The correlation coefficient shows the strength of the linear relationship amongst the selected variables under study.

Carbon performance (*GHG*) was found to be positively and significantly correlated with firm size (*SIZE*), firm profitability (*ROA*), and liquidity (*CASH*), with coefficients of 0.339, 0.272, and 0.378, respectively. This suggests that in smart cities, the firm's size and profitability are positively correlated with carbon emissions because, as the companies become larger and earn more profit, more activities will happen that will increase carbon emissions. This also suggests that when a firm has a higher ability to pay its short-term obligations, it can earn more resources, which might emit higher emissions. Further, financial performance (*TQ*) was found to be positive and significantly correlated with the *MTB* value, with a coefficient of 0.768, whereas tangible assets (*PPE*) have an inverse relationship with *TQ*, with a coefficient of 0.285. Based on the results, it can be observed that in smart cities, the firm's *MTB* ratio exhibits a positive correlation with financial performance. Additionally, when the firm acquires a higher proportion of non-current assets, it tends to experience a decline in its financial performance. *CGQ* has a significant positive relationship with *SIZE* and *ROA*, with coefficients of 0.306 and 0.294, respectively.

Another important implication of analysing the correlation matrix is the identification of multicollinearity amongst independent variables. Based on Table 5, none of the correlation coefficients between the independent variables are above 0.80. Hence, it can be inferred that the problem of multicollinearity is not a concern and will not affect our regression results (Tabachnick and Fidell, 2007).

Table 5: Correlation Matrix

Variable	*GHG*	*TQ*	*CGQ*	*SIZE*	*ROA*	*LEV*	*MTB*	*PPE*	*GROWTH*	*CASH*
GHG	1.000									
TQ	.002	1.000								
CGQ	.201	-.057	1.000							
SIZE	.339**	-.150	.306**	1.000						
ROA	.272*	.137	.294**	.164	1.000					
LEV	-.09	-.093	.145	0.020	0.201	1.000				
MTB	.057	.768***	-.004	0.089	0.175	0.175	1.000			
PPE	.202	-.285**	.235	0.085	-0.016	-0.16	-0.235	1.000		
GROWTH	-.055	.025	.042	0.042	0.323**	0.323**	-0.023	0.008	1.000	
CASH	.378***	.118	.104	0.332**	0.255*	-0.53	0.142	0.071	-0.096	1.000

Note: ***, **, and * indicate the level of significance at 1%, 5%, and 10%, respectively.
Source: Authors.

4.3. Multivariate Analysis

Table 6 reports the estimation results of the carbon performance and financial performance models for the entire sample of smart city firms, including both carbon-intensive and non-carbon-intensive industries.

Table 6: Regression Results (Overall)

Variable	Model 1			Model 2		
	β	t	Sig.	β	t	Sig.
GHG	-	-	-	-0.042	-0.450	0.655
TQ	-0.043	-0.318	0.752	-	-	-
CGQ	0.163	1.234	0.223	0.009	0.100	0.921
SIZE	0.239	1.742	0.088	-0.220	-2.519	0.015
ROA	0.188	1.385	0.173	0.003	0.029	0.977
LEV	-0.07	0.524	0.602	0.010	0.106	0.916
MTB	0.04	0.027	0.979	0.787	9.020	0.000
PPE	0.176	1.337	0.188	-0.111	-1.179	0.244
GROWTH	-0.019	-0.14	0.89	0.043	0.468	0.642
CASH	0.378	2.855	0.006	0.009	0.100	0.921
Adjusted R^2		0.581			0.622	
F-Test		0.000			0.015	

Note: ***, **, and * indicate the level of significance at 1%, 5%, and 10%, respectively.
Source: Authors.

For Model 1, the explanatory power of the models as inferred from the adjusted R^2 is .581, indicating that the independent variables explained 58.1% of the changes in carbon performance. However, the results show that corporate governance is not associated with carbon performance. Further analysis also indicates that the composition of the board, specifically in terms of gender diversity, does not exert any influence on carbon performance (Appendix B). The lack of significant results may be attributed to the time frame of the study, which only covers 2021. The findings of this study are consistent with Cordova, Zorio-Grima, and Merello (2021), conducted in developing countries, indicating that corporate governance attributes may not play a significant role in determining a firm's carbon performance. However, these results contradict the findings of Elsayih, Datt, and Tang (2021) in Australia, Konadu et al. (2022) in the United States, and Nuber and Velte (2021) in Europe, who found a significant

relationship between corporate governance and carbon performance in their respective countries. This implies that developed countries have regulated and close monitoring of carbon emissions compared with developing countries. According to Ferrero-Ferrero, Fernández-Izquierdo, and Muñoz-Torres (2016), the implementation of such robust governance practices is crucial for enhancing pollution control in both firms and countries.

Amongst the control variables, it is evident that only liquidity (*CASH*) has a discernible influence on carbon performance. This suggests that when a firm has a higher ability to pay its short-term commitments, it could earn more resources that increase carbon emissions. This result is against the findings of Alam, Safiullah, and Islam (2022), who found that firms with higher corporate cash holdings tend to exhibit lower levels of carbon emissions. Their finding indicates that *CASH* plays a role in mitigating carbon emissions through the promotion of renewable energy consumption and investment in carbon abatement projects.

In the case of Model 2, the adjusted R^2 shows that the model's explanatory power is 0.622, suggesting that the independent variables in this model captured 62.2% of the fluctuations in financial performance. Table 6 shows that carbon performance has a negative but insignificant coefficient with financial performance, as measured by *TQ*. The results convey that carbon performance results in increased financial performance, aligning with the findings of Meng, Gou, and Chen (2023). Han et al. (2023) suggested that Asian investors tend to pay little attention to CSR and environmental protection, demonstrating a lack of appreciation of the significance of these issues and assigning too little weight to environmental and social factors when making decisions. This observation may be pertinent to the Malaysian context, which is explained by the insignificant correlation between carbon emissions and financial performance.

When examining the influence of corporate governance on financial performance, the results reveal a positive and insignificant coefficient between the corporate governance score and *TQ*. It is evident that the composition of the board, particularly regarding gender diversity, does not exhibit any noticeable influence on financial performance. The lack of significant findings can be attributed to the study's restricted time frame, which only covers 2021. While it is generally believed that better governance is associated with higher firm valuations, this study indicates that practising good corporate governance does not significantly influence the market value of the firm (Aman and Nguyen, 2008). This finding is consistent with the research conducted by Al-Ahdal et al. (2020) in India.

In terms of control variables, the results show that firm size (*SIZE*) is the main attribute and has a significant negative impact on financial performance, which indicates that the larger

the firm's size, the lower the firm's financial performance (Ghose, Makan, and Kabra, 2022). This reinforces the view that larger firms are likely to invest in more assets to support their operations, which might increase the replacement cost of the firm's assets and lower its financial performance. In contrast, *MTB* has a significant positive effect on financial performance in the sample. This implies that prospectus companies tend to have higher market valuations, resulting in improved financial performance (Puspitaningtyas, 2017; Rjiba, Jahmane, and Abid, 2020).

4.4. Subsample Analysis

4.4.1. Impact of corporate governance quality on carbon performance

This section reports additional analysis used to support the main research findings. Table 7 shows that corporate governance has an insignificant impact on carbon performance in both carbon-intensive and non-carbon-intensive industries. This finding suggests that in Malaysia, just a few firms have acknowledged the need for environmental sustainability, while others might prioritise short-term financial benefits ahead of long-term environmental issues (Andrew and Cortese, 2011). Therefore, their governance approaches are insignificantly focused on carbon performance.

Table 7: Model 1 – Impact on Carbon Performance

Variable	Carbon-intensive			Non-carbon-intensive		
	β	**t**	**Sig.**	**β**	**t**	**Sig.**
GHG	-	-	-	-	-	-
TQ	-0.08	-0.55	0.59	0.08	0.41	0.68
CGQ	0.19	1.14	0.27	-0.09	-0.46	0.65
SIZE	0.99**	2.36	0.03	0.04	0.21	0.83
ROA	-0.01	-0.07	0.94			
LEV	0.13	0.80	0.59	-0.33*	-1.76	0.09
MTB	0.03	0.21	0.83	0.05	0.24	0.81
PPE	0.83	0.52	0.61	8.55**	2.38	0.03
GROWTH				-0.009	-0.046	0.96
CASH	1.56**	0.59	0.02	0.12	0.59	0.56
Adjusted R2		0.38			0.17	
F-Test		8.81 (0.01)			5.67 (0.03)	

Note: ***, **, and * indicate the level of significance at 1%, 5%, and 10%, respectively.
Source: Authors.

For control variables, the result shows that firm size (*SIZE*) positively impacts carbon performance rate at a 5% level of significance. This suggests that the bigger the carbon-intensive firm, the greater its ability to earn more resources that increase carbon emissions. Consistent with Nuber and Velte (2021) and Oyewo (2023), the finding suggests that larger firms in Europe tend to have higher carbon emissions levels. However, in the case of non-carbon-intensive industries, *SIZE* was found to have an insignificant impact on carbon performance.

Likewise, the liquidity (*CASH*) of the firm has a significantly positive impact on carbon performance. This suggests that the higher the firm's ability to pay its short-term obligations, the greater its ability to earn more resources that increase carbon emissions. This result is consistent with Nuber and Velte (2021) and Oyewo (2023) for cities in Europe. Contrary to the carbon-intensive industries, the non-carbon-intensive industry portrays the insignificant impact of *CASH* of the firm on carbon performance.

However, the tangible assets (*PPE*) and leverage (*LEV*) of the firm are the main attributes and have a significant impact on carbon performance in the non-carbon-intensive industry. Specifically, *LEV* shows a positive impact on carbon performance, which indicates that the higher the leverage, the better the carbon performance. Contrary to the carbon-intensive industry, the result shows that leverage impacts carbon performance insignificantly.

Despite that, *PPE* was found to be positive and significantly impact the carbon performance in the non-carbon-intensive industry but insignificantly impact the carbon performance in the carbon-intensive industry. This suggests that the non-carbon-intensive industry earns more non-current assets and generates substantial GHG emissions due to heavy machinery and equipment usage, especially when the primary source of energy is fossil fuels (Jassim, 2019). This might be due to the limitations of energy-efficient and green technology investments in the firm.

In addition to conducting thorough research on these data, this study endeavours to explore the correlation between corporate gender and carbon performance. Female board members possess various aspects of human and relational capital that can be leveraged to promote carbon-related strategies and enhance a firm's carbon performance (Haque, 2017). Eco-feminist literature provides evidence of gender differences in human and environmental relations, indicating that females have a stronger inclination towards environmental preservation (Li, Wang, and Saechang, 2022). This is evident in the heightened environmental concern shown by female directors compared with their male counterparts, which can be attributed to their reproductive and nutrient roles (Lv and Deng, 2019) as well as the communal

values, ethics, and traits associated with women. These characteristics enhance their sensitivity towards building relationships and aligning stakeholders' interests with socially responsible and environmentally sustainable initiatives (Nuber and Velte, 2021). Consequently, female directors bring a different approach to leadership and organisational strategy compared with male directors; show inclusive attitudes on public issues such as renewable energy consumption and environmental protection; and contribute positively to society, the environment, and sustainable development (Issa, 2023; Liao, Luo, and Tang, 2015; Nuber and Velte, 2021).

According to Xie, Nozawa, Managi (2020) and Nuber and Velte (2021), culturally feminine organisations tend to foster participative decision-making and open discussions while prioritising social and environmental responsibilities to meet stakeholders' expectations. This fosters effective monitoring of CSR activities by the board (Fan, Qian, and Wang, 2023). Moreover, female board members are more likely to promote innovation in the corporate social strategy, with a particular emphasis on long-term perspectives and non-financial performance outcomes such as carbon performance (Glass, Cook, and Ingersoll, 2015).

Emerging research highlights the significant contribution of female directors to influencing a firm's carbon performance. Multiple studies substantiate the positive impact of gender-diverse boards on facilitating enhanced carbon performance for organisations (Elsayih, Datt, and Tang, 2021; Goud, 2022; Konadu et al., 2022; Nuber and Velte, 2021; Oyewo, 2023; Toukabri and Jilani, 2022). Furthermore, empirical evidence from recent research conducted by Fan, Qian, and Wang (2023) supports the notion that firms with female outside directors exhibit a higher probability of achieving reduced carbon emissions.

4.4.2. Impact of Corporate Governance Quality on Financial Performance

The following section discusses the outcome of the interaction between corporate governance and financial performance, as well as between carbon performance and financial performance. The findings presented in Table 8 indicate that corporate governance has a negligible impact on financial performance for both carbon-intensive and non-carbon-intensive companies. This suggests that many firms may adopt corporate governance practices merely to fulfil legal requirements rather than fully adopting their fundamental ideals (Abu-Tapanjeh, 2009). As a result, governance practices may not be rigorously enforced, leading to a limited influence on financial performance.

Table 8: Model 2 – Impact on Financial Performance

Variable	Carbon-intensive			Non-carbon-intensive		
	β	t	Sig.	β	t	Sig.
GHG						
TQ						
CGQ	-.0.05	-0.29	0.77	0.09	0.96	0.35
SIZE	-0.05	-.0.29	0.77	-0.24***	-0.41	0.00
ROA	-.0.03	-0.18	0.86			
LEV	0.17	1.13	0.27	-0.06	-0.64	0.53
MTB	0.29***	4.57	0.00	0.43***	9.56	0.00
PPE	-.023	-1.59	0.13	-0.05	-0.51	0.62
GROWTH				0.038	0.41	0.69
CASH	0.19	1.27	0.22			
Adjusted R^2		0.43			0.82	
F-Test		20.89 (0.00)			53.06 (0.00)	

Note: ***, **, and * indicate the level of significance at 1%, 5%, and 10%, respectively.
Source: Authors.

For control variables, the *MTB* value is the most important factor and has a considerable beneficial influence on financial performance in both carbon-intensive and non-carbon-intensive companies. This suggests that a higher market value boosts investor confidence, which boosts financial performance (Puspitaningtyas, 2017).

However, firm size (*SIZE*) is one of the main attributes and has a significantly negative impact on financial performance in the non-carbon-intensive industry. This suggests that smaller, non-carbon-intensive firms have better financial performance. This might be due to lower financial and market risks, which increase investors' attraction to the firm. The findings are consistent with those of Herlambang, Murhadi, and Andriani (2020) for Indonesia, which indicated that the financial performance of a firm can be adversely impacted by its size, possibly due to factors such as agency problems and agency costs. Likewise, a better market valuation increases investors' confidence, which would increase their financial performance (Puspitaningtyas, 2017).

4.5. Qualitative Survey

Following the results shown in the earlier section, a survey was conducted to strengthen and extend the results. The survey was conducted from March to May 2023 and covers two sections: the demographic profile and the carbon reporting practices in the organisation. The demographics section focused on gathering information about the basic profile of the respondents and organisation, while the carbon reporting practices section encompasses four parts; awareness, best practices, challenges, and future initiatives.

4.5.1. Participant Demographics

The survey began by seeking the profile of the respondent. Slightly more than half (57.1%) of the respondents are female, and the remainder (42.9%) are male. In terms of age, the highest proportion falls within the age range of 25–34 years (71.4%), while 14.3% belong to the age group of 55–64 years, and the remaining 14.3% are over the age of 65. With respect to the respondent's position within their respective organisation, more than half of the respondents (57.1%) indicated they hold an executive position, 14.3% hold a human resources position, 14.3% hold a supervisor position, and the remainder hold a director position.

The demographics section subsequently delved into the composition of the respondents. Regarding their location, 42.9% of the respondents are based in Kuala Lumpur, another 42.9% in Johor, and the remaining portion in Melaka. These companies are predominantly Malaysian, primarily hailing from the property industry (42.9%), with construction (28.6%) and financial services (28.5%) following closely behind. In terms of the size of their organisation, most respondents (71.4%) work for companies with more than 200 employees, followed by companies with 25–200 employees (28.1%) and companies with 30–74 employees (14.3%). Looking at the year of incorporation, respondents mostly work for organisations that were incorporated more than 30 years ago (71.4%), followed by organisations incorporated 11–15 years ago, and organisations incorporated 26–30 years ago. In addition, the survey delved into whether organisations had dedicated sustainability departments, and it shows that 86% of the respondents are employed by companies with dedicated sustainability departments.

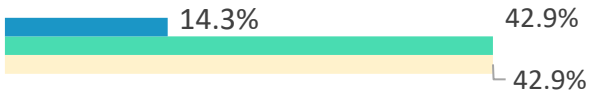
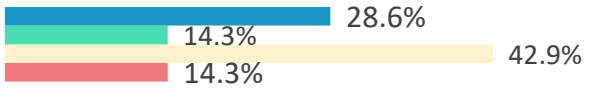
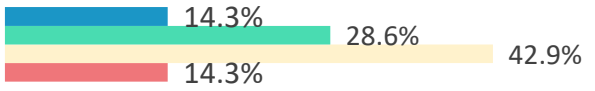
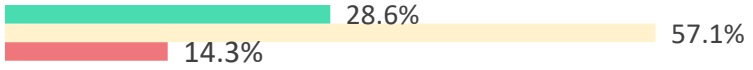
4.5.2. Carbon reporting practices in organisations

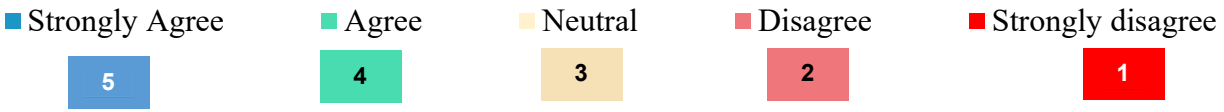
The respondents were asked about their awareness of carbon reporting practices in their organisations (Figure 2). Based on the responses, it is evident that many companies are still hesitant to make sustainability a top priority, despite being highly aware of the importance of carbon reporting practices. This is reflected in the high percentage of respondents who believe

that carbon reporting practices should be tackled first because they are low-hanging fruit. However, almost half of the respondents also believe that business performance and survival should take priority over carbon reporting practices. Interestingly, in terms of carbon reporting practices, 85.7% of respondents believe that their firm is still in the awareness stage. This situation is reflected in the findings of KPMG and MICPA Malaysia (2022), which indicated that Malaysia ranks amongst the top countries in the Asia-Pacific region in terms of sustainability reporting. However, simultaneously, Abd Rahman, Abdul Rasid, and Basiruddin (2019) discovered that the calibre of carbon reporting in sustainability reports remains deficient, emphasising its symbolic rather than substantial nature.

When considering both carbon-intensive and non-carbon-intensive companies, there is no notable disparity in their level of awareness. However, non-carbon-intensive companies tend to prioritise their business performance and survival over environmental practices. This preference may arise from the significant pressure exerted by carbon-intensive companies to mitigate environmental impacts. Consequently, non-carbon-intensive companies strive to maintain a positive public image and gain legitimacy from both the public and their shareholders.

Figure 2: Awareness of Carbon Reporting Practices

Instrument	Awareness amongst Respondents	Average Level of Awareness	
		Carbon	Non-carbon
My firm views that disclosure is the first step in any net zero carbon journey		4	4
In my firm's opinion, financial literacy (i.e., knowledge, attitude, and awareness) is advantageous for carbon reporting practices		4	4
My firm believes that carbon reporting practices should be tackled first because they are low hanging fruit		4	4
In my firm's opinion, business performance and survival are more important than carbon reporting practices		3	4
In terms of carbon reporting practices, my company is still in the awareness stage		3	3



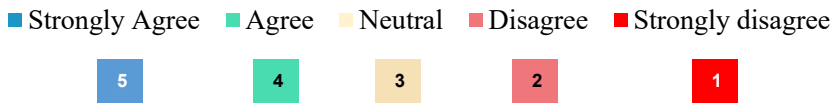
Source: Authors' compilation based on survey results.

This section also includes questions about companies' best practices in carbon reporting (Figure 3). Companies clearly believe that independent carbon verification and assurance are crucial for effective carbon reporting practices within an organisation. This implication is demonstrated by the percentage of respondents who believe in the significance of independent carbon verification and assurance for providing credible and reliable carbon reporting. More than half of the respondents (57.1%) hold this belief. Unfortunately, only 28.6% of companies believe that there are sufficient national guidelines and frameworks to support carbon reporting.

In terms of comparison between carbon-intensive and non-carbon-intensive companies, there were no big differences in the best carbon reporting practices. However, for carbon-intensive industries, they believe that their national framework is insufficient to guide their carbon reporting practices. This perception stems from the additional pressure experienced by carbon-intensive companies in contrast to non-carbon-intensive companies.

Figure 3: Best Carbon Reporting Practices

Instrument	Best Practices amongst Respondents	Average Level of Best Practice	
		Carbon	Non-carbon
According to my firms, independent carbon verification and assurance is important in providing credible and reliable carbon reporting		4	4
According to my firms, there is sufficient guidelines and framework at national level to support carbon reporting		4	3

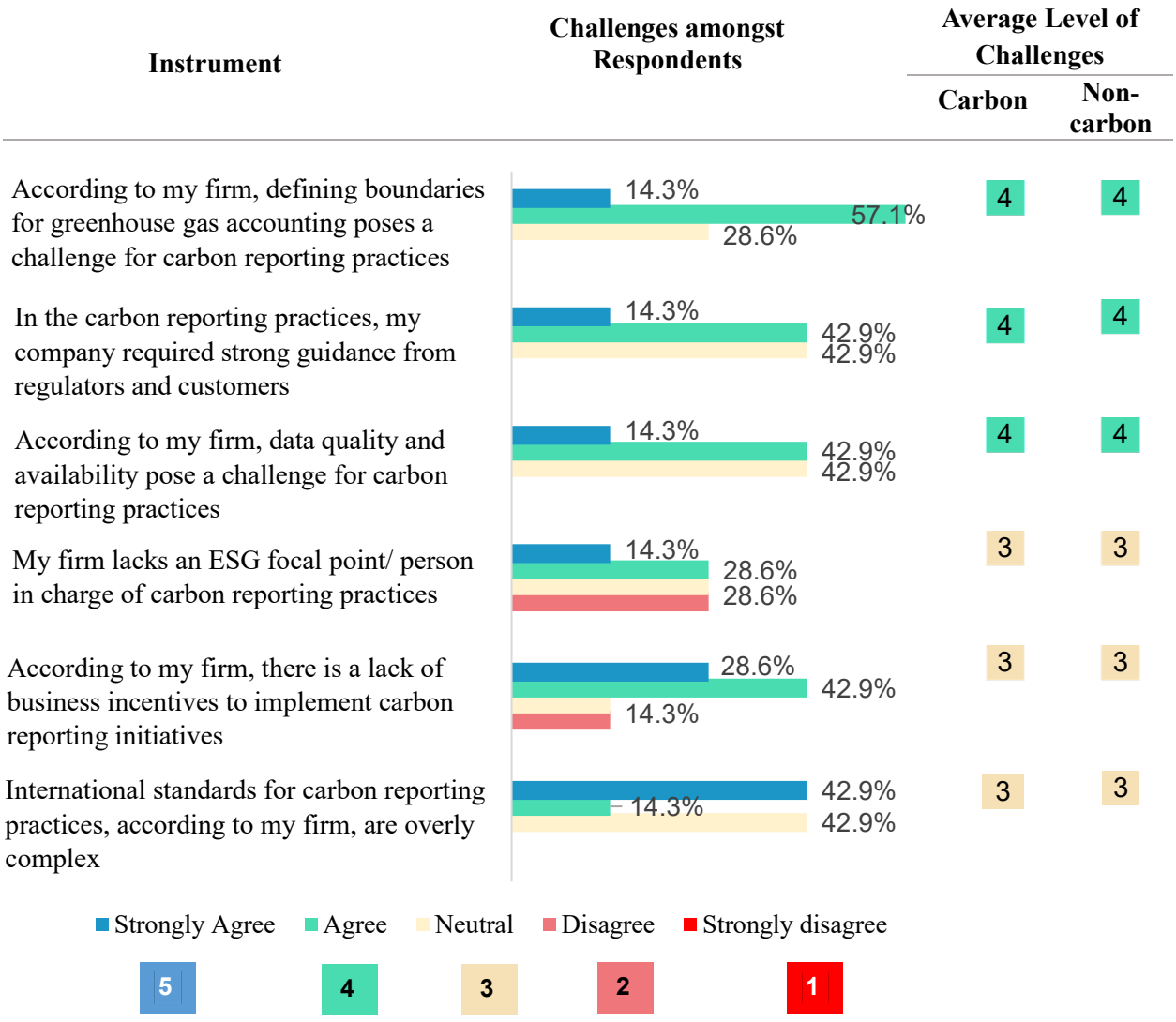


Source: Authors' compilation based on survey results.

The section continues with the question of the challenges of carbon reporting experienced by the respondents (Figure 4). The response shed light on the significance of simplifying and centralising the complexity of carbon reporting to encourage more efficient carbon reporting practices. Evidently, a substantial proportion of companies (57.2%) expressed concern that

international standards for carbon reporting practices are overly complex. Moreover, most respondents (57.2%) concurred that they require strong guidance from regulators and customers to navigate the complexities of carbon reporting. Furthermore, a significant number of companies (71.4%) acknowledged the formidable challenge they face in defining boundaries for greenhouse gas accounting. Interestingly, 71.5% of companies opine that there is a lack of business incentives to implement carbon reporting practices. In a comparison between the carbon-intensive and non-carbon-intensive industries, the carbon-intensive firm perceived fewer challenges in carbon reporting than the non-carbon-intensive firm.

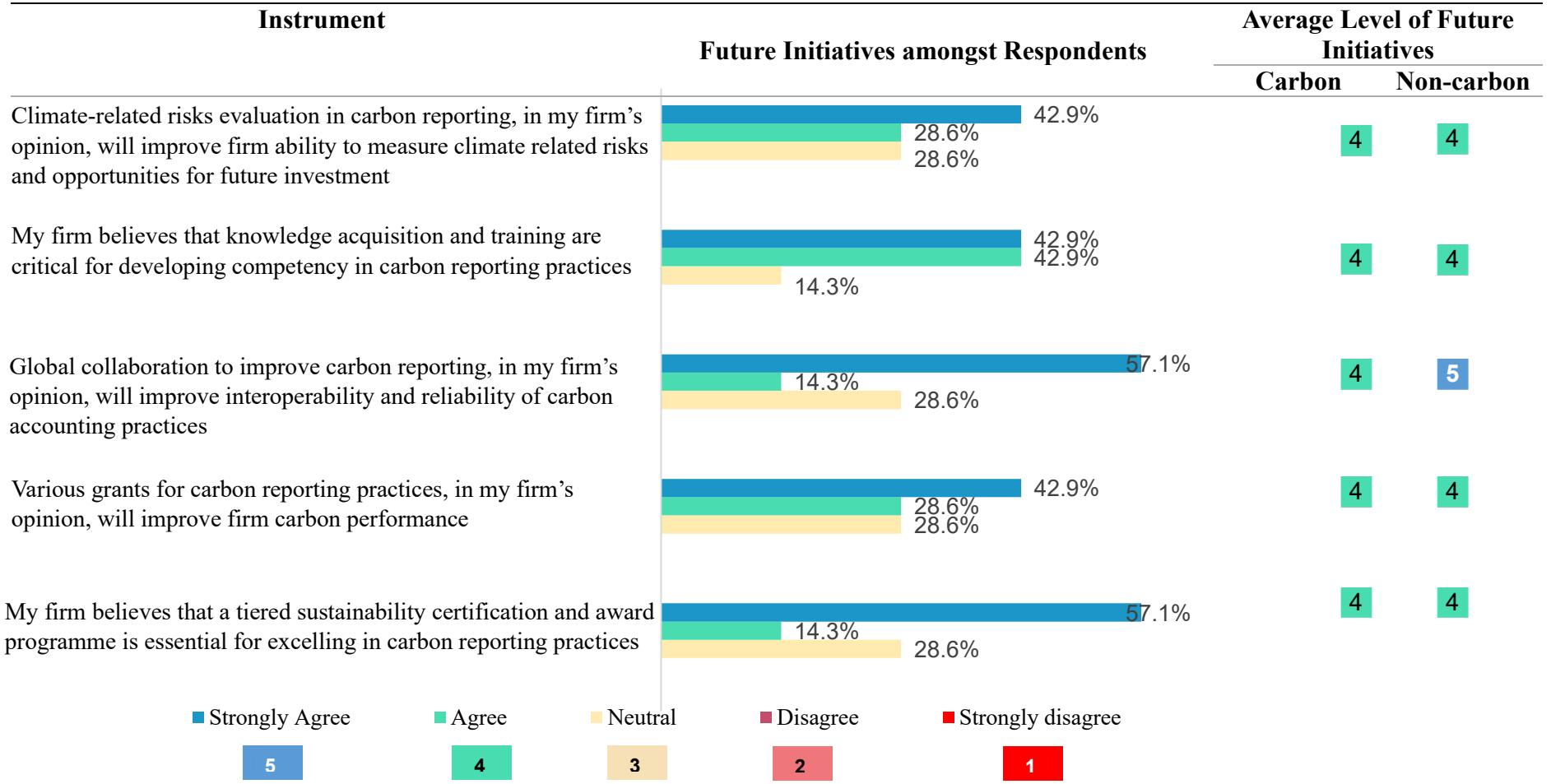
Figure 4: Challenges to Carbon Reporting



ESG = environmental, social, and governance.
Source: Authors' compilation based on survey results.

The section concludes by addressing the inquiries regarding future initiatives in carbon reporting (Figure 5). Interestingly, 85.8% of respondents believe that knowledge acquisition and training are critical for developing competency in carbon reporting practices. Specifically, a substantial percentage of companies (71.4%) expressed agreement with the notion that a tiered sustainability certification and award programme is crucial for attaining excellence in carbon reporting practices. Establishing a framework for companies to measure their emissions is therefore a critical first step (Ka-Jhun, 2021). Furthermore, a significant majority of companies (71.4%) agreed that global collaboration aimed at enhancing carbon reporting would lead to improved interoperability and reliability in carbon accounting practices. In terms of a comparison between carbon-intensive and non-carbon-intensive industries, non-carbon-intensive companies were more likely to welcome global collaboration to improve their carbon reporting practices compared with carbon-intensive companies, possibly due to the strong pressure to maintain their legitimacy.

Figure 5: Future Carbon Reporting Initiatives



Source: Authors' compilation based on survey results.

In a nutshell, the survey shows that all companies are aware of the importance of good carbon reporting practices, although they still prioritise business performance and survival over carbon reporting. A notable challenge highlighted by the respondents is the complexity associated with carbon reporting, which hampers the efficiency of their reporting practices. Although Bursa Malaysia has introduced a standardised framework for carbon reporting, the national framework and guidelines remain inadequate, limiting companies' ability to adhere to standardised practices. A survey by KPMG and MICPA Malaysia (2022) also highlighted that the Malaysian government's commitment to net zero at the 2021 United Nations Climate Change Conference (COP26) is a positive move; nevertheless, the lack of a climate regulatory framework is a cause for concern.

4.5.3 Analysis of carbon reporting practices on carbon performance and financial performance

Table 9: Carbon Reporting Practices of Carbon-Intensive and Non-Carbon-Intensive Firms on Carbon Performance and Financial Performance

Mean Value	Survey				Model 1	Model 2
	Awareness	Best Practices	Challenges	Future Initiatives	GHG	TQ
Carbon-intensive	3	4	3	4	909.55	1.4
Non-carbon-intensive	4	4	4	4	13,879.93	3.5

GHG = greenhouse gas is in the unit of Million metric tons of carbon dioxide equivalent ($MtCO_2e$), TQ = Tobin's Q.
Note: If the TQ exceeds 1.0, it indicates that a firm's current market value surpasses its total asset value, which reflects that the firm has made successful investment decisions (Campbell and Mínguez-Vera, 2008).
Source: Authors' analysis based on survey results.

Table 9 presents the comparative results of overall carbon reporting practices related to carbon performance and financial performance in smart cities, distinguishing between carbon-intensive and non-carbon-intensive firms. The findings concerning carbon reporting practices generally indicate a mix of results. Notably, the study indicates that non-carbon-intensive firms hold more favourable views towards carbon reporting practices across all aspects (i.e. awareness, best practices, challenges, and future initiatives) compared with carbon-intensive firms (Luo et al., 2023). These findings suggest that, on average, carbon-intensive firms exhibit

lower levels of both carbon performance and financial performance compared with non-carbon-intensive firms.

In the case of carbon-intensive firms, the findings support the notion that the adoption of new technology, despite its associated costs, can result in improved energy efficiency and facilitate the attainment of carbon reduction objectives. On the other hand, in non-carbon-intensive industries, companies tend to prioritise maximising profits and enhancing financial performance rather than investing in carbon-efficient production technologies, processes, and carbon management strategies that could potentially lead to higher emissions (Konadu, 2018; Ott and Schiemann, 2023). This observation aligns with the concept of the Environmental Kuznets Curve proposed by Grossman and Krueger (1991), which suggests that less developed nations prioritise economic and financial growth initially. Once economic and financial requirements are met, they can then focus on implementing emissions reduction plans (Bekhet and Othman, 2017; 2018).

5. Conclusions and Policy Implications

Smart cities possess the technological capabilities, real-time monitoring systems, sustainable infrastructure, citizen engagement, and potential for global leadership that make them ideal champions in carbon reporting practices. By leveraging these strengths, smart cities can play a vital role in measuring, managing, and mitigating carbon emissions, contributing significantly to the global effort to combat climate change.

At the city level, the findings demonstrate that size and liquidity have a positive impact on the carbon performance of carbon-intensive firms. This reinforces the view that larger carbon-intensive firms are likely to leverage assets that would have sufficient benefits to outweigh the cost of carbon, which would improve their financial performance. Within non-carbon-intensive industries, the asset tangibility and leverage wield considerable influence over a firm's emissions levels, whereas reduced financial risk and enhanced financial stability notably shape the firm's overall financial performance. This reinforces the argument that the firm's reliance on less energy-efficient equipment and its limited ability to invest in energy-efficient technologies contribute to its increased energy requirements, which in turn affects its financial performance.

The findings have important implications for managers of carbon-intensive firms, regulators, policymakers, and investors. First, carbon-intensive firms should understand and increase the awareness of carbon management, carbon accounting, and carbon reporting

practices as a business strategy to improve carbon and financial performance. It is also important that firms engage with their stakeholders and business supply chains to incorporate carbon and GHG disclosure into business strategies that could lead to carbon performance and financial performance.

Second, while the current finding provides evidence that current corporate governance has no relationship with or implications on carbon and financial performance, regulators should strengthen the regulatory framework by enhancing and enforcing regulations related to corporate governance, ensuring that they are comprehensive, transparent, and aligned with internationally recommended best practices such as the United Nations Guidance on Good Practices in Corporate Governance Disclosure (UNCTAD, 2006). This could include updating the existing MCCG (2021) and introducing new regulations to improve the corporate governance code.

Third, since the current findings provide evidence that a firm's carbon performance does not significantly impact its financial performance, regulators may consider promoting and encouraging firms to conduct climate change reporting, like many regulators in various parts of the world. Currently, Bank Negara Malaysia is taking proactive steps to streamline disclosures for financial institutions, aligning them with the Task Force on Climate-Related Financial Disclosures (TFCD). Similar guidelines are required to provide additional guidance on climate-related disclosures for non-financial firms. The TFCD would then enable firms to assess and address climate-related risks, create proper strategies, and explore new opportunities for lending and investment to improve carbon performance, leading to enhanced financial performance.

Fourth, policymakers and regulators could advocate for transparent and standardised carbon disclosure and reporting practices for companies in smart cities. This policy initiative would encourage companies to measure and disclose their carbon emissions, set reduction targets, and report progress against those targets. This would enable a better assessment of a firm's carbon performance and facilitate informed investment decisions. Furthermore, the government should strengthen the ASEAN Smart Cities Network related to quality carbon reporting by focusing on city-level and scalable solutions to improve corporate governance, carbon performance, and financial performance. The regional network platform is commendable and vital to encourage Association of Southeast Asian Nations (ASEAN) cities to be proactive in tapping capital opportunities for social and economic impacts, accessing the global market, connecting global experts, and exchanging knowledge within ASEAN cities.

Fifth, while capital (both debt and equity) is increasingly demanding climate-related financial disclosures from companies, banks and institutional investors play a crucial role in supporting firms to enhance their business resilience towards carbon performance. Banks and institutional investors could incentivise and support firms in their journey towards improving carbon performance and building business resilience by leveraging their financial influence and expertise. For instance, banks and institutional investors could assess the carbon-related risks faced by companies in their portfolios and work with firms to develop ESG assessments and integrate carbon performance metrics into risk management frameworks.

To address these issues, it is recommended to establish a centralised framework at the national level, or preferably the international level, for reporting carbon practices. As revealed by the survey, these companies express a desire for global collaboration, believing that it would foster improved interoperability and reliability in carbon accounting practices. Such an initiative would prove beneficial in assisting and supporting companies that possess the motivation to engage in effective carbon reporting practices but face hesitancy due to external inefficiencies. As carbon reporting will be mandatory in Malaysia starting in 2025, businesses in smart cities must disclose and reduce their carbon performance in line with the goals of these cities. The city councils of smart cities could actively engage and educate firms about sustainability practices and the importance of carbon reduction. Transparent and accessible carbon reporting plays a crucial role in raising awareness amongst firms about their carbon footprint and the collective efforts needed to combat climate change. When firms are informed and empowered, they can actively participate in reducing emissions and contribute to the overall sustainability goals of the city. Furthermore, since smart governance is an important aspect of smart cities, companies located in smart cities could utilise advanced technologies and data analytics to collect, analyse, and interpret the data for valuable insights into the city's energy consumption, patterns, and other carbon-emitting activities. By harnessing these data, smart cities could accurately measure and report their carbon emissions, identify areas of high impact, and make informed decisions on mitigation strategies. For instance, firms could initiate or invest in a digital board management system that would allow them to oversee all board operations and duties through a single, transparent, and accessible system. Consequently, within smart cities, both the workforce and the community have the opportunity to closely monitor strategic decisions regarding carbon reporting procedures. To ensure consideration in decisions aimed at reducing carbon emissions, it is also crucial for businesses operating in smart cities to establish a board of directors that embodies a commitment to sustainable

development within the organisation or collaborate closely with city councils on sustainability initiatives.

While sustainable reporting is gaining traction in Malaysia, there is still progressed to be made in terms of widespread adoption and standardisation. Efforts are being made at the national level to improve reporting quality, enhance data comparability, and increase the integration of sustainability considerations into corporate strategies. By leveraging smart cities' technological strengths and capabilities, it is expected that sustainable reporting, especially for firms at the city level, will continue to develop and become a more integral part of business practices in Malaysia in the coming years.

6. Limitations and Future Recommendations

This study is subject to several limitations that may impact the interpretation and generalisability of the findings. Looking at the quantitative analysis, the use of secondary data is limited by the sample size, as the data set was initially sourced from 253 companies with carbon emissions data but was subsequently refined to 51 companies, representing only 20% of the original population. This smaller sample size offers less opportunity to capture the correlation between variables and increases the likelihood of type II errors. Furthermore, the study is constrained by a limited time frame, focusing primarily on data published in 2021. Moreover, it is important to acknowledge that the methodology employed in this report is confined to correlation analysis, thereby capturing associations between variables without establishing causality.

With respect to the qualitative analysis, the sample size for the survey conducted encompassed 253 companies that were publicly listed in Bursa Malaysia and located in Putrajaya, Melaka, Johor, and Kuala Lumpur. However, the distribution of respondents across these regions was uneven, and there was a lack of representation from Putrajaya, one of the four smart cities in Malaysia. This geographic bias may limit the generalisability of the findings and provide an incomplete picture of the perceptions and practices of companies in different regions. Moreover, the presence of measurement errors is a concern, as most respondents held executive-level positions, while only a small proportion (14.3%) represented directors. This imbalance in respondents' positions may introduce measurement errors, potentially restricting the depth and accuracy of the data collected. These limitations need to be considered when interpreting and generalising the findings from the primary data model.

To enrich the findings and provide a broader perspective, future studies should consider benchmarking the observed practices in Malaysia with those of other countries. This comparative analysis would involve examining carbon reporting practices across different regions and comparing and contrasting them to identify variations, best practices, and potential policy implications. By studying international perspectives, researchers could gain insights into successful strategies and innovative approaches that could be adapted and implemented in the Malaysian context. This broader perspective would expand the potential effective policies and provide a framework for carbon reporting.

Additionally, it is recommended that researchers focus on expanding the sample size to enhance the representativeness of the findings. By including a larger and more diverse sample of companies, the results could better reflect the broader population and provide more robust conclusions. Researchers could also expand the time frame by conducting longitudinal analyses. By expanding the time frame and collecting data at multiple points, researchers could track changes and establish more accurate correlations and causal relationships. It is worth noting that digital transformation is crucial to realising city smartness. As such, the current study could be extended to explore new information or instruments related to digital technology innovation and its association with the concept of smart cities to promote the adjustment of industries and the city's carbon emissions. Future research might also investigate and compare Malaysia's smart cities' carbon reporting practices to those of other smart cities in Asia and throughout the globe.

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Appendixes

Appendix A

Survey Instruments: Key Inquiries on Carbon Reporting Practices

GHG = greenhouse gas.
Source: The illustration originates from the survey form supplied to respondents by the author.

Appendix B

Relationship Amongst Corporate Governance Elements, Carbon Performance, and Financial Performance

1. Analysis on the influence of board leadership and effectiveness (BLE), effective audit and risk management (EARM), and integrity in corporate reporting and meaningful relationship with stakeholders (IRCMRS) on carbon performance (Model 1)

Model 1:

$GHG = \beta_0 + \beta_1 BLE + \beta_2 EARM + \beta_3 ICRMRS + \beta_4 SIZE + \beta_5 ROA + \beta_6 LEV + \beta_7 MTB + \beta_8 PPE + \beta_9 GROWTH + \beta_{10} CASH + e$

Model Summary

Model	R	R^2	Adjusted R^2	Std. error	Change Statistic					Durbin-Watson
					R^2 change	F change	df1	df2	Sig. F	
1	0.482	0.232	0.040	5.639	0.232	1.210	10	40	0.314	2.265

Source: Authors' own data analysis.

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	384.934	10	38.493	1.210	0.314
	Residual	1,272.361	40	31.809		
	Total	**1,657.294**	**50**			

ANOVA = Analysis of Variance.
Source: Authors' own data analysis.

Coefficients

Model		Unstandardised coefficients		Standardised Coefficients Beta	t	Sig.
		B	Std. error			
1	(Constant)	8.809	13.874		0.635	0.529
	ble	0.074	0.116	0.099	0.636	0.528
	earm	-0.100	0.104	-0.154	-0.956	0.345
	icrmrs	0.033	0.087	0.057	0.384	0.703
	size	3.0165E-11	0.000	0.202	1.244	0.221
	roa	3.827	5.943	0.093	0.644	0.523
	lev	0.431	4.688	0.022	0.092	0.927
	mtb	0.013	0.070	0.029	0.180	0.858
	ppe	2.815	2.100	0.196	1.1341	0.188
	growth	-0.013	2.979	-0.001	-0.004	0.997
	cash	1.802	0.0902	0.311	1.997	0.053

Source: Authors' own data analysis.

Residual Statistics

	Minimum	Maximum	Mean	Std. deviation	N
Predicted value	7.417	19.202	11.638	2.774	51
Residual	-14.615	13.026	0.000	5.045	51
Std. predicted value	-1.522	2.726	0.000	1.000	51
Std. residual	-2.591	2.310	0.000	0.894	51

Source: Authors' own data analysis.

Coefficients (Stepwise)

Model		Unstandardised Coefficients		Standardised Coefficients Beta	t	Sig.
		B	Std. error			
1	(Constant)	10.358	0.928		11.159	0.000
	cash	1.921	0.781	0.331	2.459	0.018

Source: Authors' own data analysis.

Model 2:

$TQ = \beta_0 + \beta_1 GHG + \beta_2 BLE + \beta_3 EARM + \beta_4 ICRMRS + \beta_5 SIZ\ E + \beta_6 ROA + \beta_7 LEV + \beta_8 PPE + \beta_9 GROWTH + \beta_{10} CASH + \beta_{11} MTB + e$

Model Summary

Model	R	R^2	Adjusted R^2	Std. error	Change Statistic					Durbin-Watson
					R^2 change	F change	df1	df2	Sig. F	
1	0.782	0.612	0.502	3.886	0.612	5.581	11	39	0.000	2.084

Source: Authors' own data analysis.

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	927.168	11	84.288	5.581	0.000
	Residual	588.989	39	15.102		
	Total	**1,516.157**	**50**			

ANOVA = Analysis of Variance.
Source: Authors' own data analysis.

Coefficients

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.
		B	Std. error	Beta		
1	(Constant)	1.146	9.608		0.119	0.906
	ble	-0.031	0.081	-0.044	-0.388	0.700
	earm	0.080	0.073	0.129	1.099	0.278
	icrmrs	0.057	0.060	0.102	0.944	0.351
	size	4.218E-11	0.000	-0.282	-2.360	0.023
	roa	3.503	4.116	0.089	0.851	0.400
	lev	-10.171	3.231	-0.549	-3.148	0.003
	mtb	0.243	0.048	0.590	5.015	0.000
	ppe	1.246	1.479	0.091	0.842	0.405
	growth	6.909	2.052	0.552	3.366	0.002
	cash	-0.872	0.652	-0.157	-1.337	0.189
	log_ghg	0.009	0.109	0.009	0.081	0.936

Source: Authors' own data analysis.

Residual Statistics

	Minimum	Maximum	Mean	Std. deviation	N
Predicted value	-5.08	23.37	2.39	4.306	51
Residual	-9.599	15.634	0.000	3.432	51
Std. predicted value	-1.735	4.871	0.000	1.000	51
Std. residual	-2.47	4.023	0.000	0.883	51

Coefficients (Stepwise)

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.
		B	Std. error	Beta		
1	(Constant)	0.567	0.672		0.844	0.403
	cash	0.265	0.045	0.643	5.884	0.000
2	(Constant)	1.070	0.681		1.572	0.123
	mtb	0.287	0.044	0.697	6.488	0.000
	size	-3.6994E-11	0.000	-0.247	-2.298	0.026

Source: Authors' own data analysis.

2. Analysis on the influence of board composition (BC) on carbon performance

Model 1:

$GHG = \beta_0 + \beta_1 BC + \beta_2 SIZ\ E + \beta_3 ROA + \beta_4 LEV + \beta_5 MTB + \beta_6 PPE + \beta_7 GROWTH + \beta_8 CASH + e$

Model Summary

Model	R	R^2	Adjusted R^2	Std. error	Change Statistic				Durbin-Watson
					R^2 change	df1	df2	Sig. F	
1	0.449	0.202	0.050	5.613	0.202	1.326	8	42	2.245

Source: Authors' own data analysis.

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	334.090	8	41.761	1.326	0.258
	Residual	1,323.204	42	31.505		
	Total	**1,657.294**	**50**			

ANOVA = Analysis of Variance.
Source: Authors' own data analysis.

Coefficients

Model		Unstandardised Coefficients		Standardised Coefficients Beta	t	Sig.
		B	Std. error			
1	(Constant)	9.091	6.518		1.395	0.170
	bc	0.010	0.066	0.022	0.150	0.882
	size	2.733E-11	0.000	0.175	1.179	0.245
	roa	4.057	5.908	0.099	0.687	0.496
	lev	-0.465	4.547	-0.024	-0.102	0.919
	mtb	-0.007	0.068	-0.016	-0.100	0.921
	ppe	2.974	2.119	0.207	1.404	0.168
	growth	0.467	2.958	0.036	0.158	0.875
	cash	1.879	0.883	0.324	2.127	0.039

Source: Authors' own data analysis.

Residual Statistics

Item	Minimum	Maximum	Mean	Std. deviation	N
Predicted value	8.937	18.536	11.639	2.585	51
Residual	-16.103	12.635	0.000	5.144	51
Std. predicted value	-1.045	2.668	0.000	1.000	51
Std. residual	-2.869	2.251	0.000	0.917	51

Source: Authors' own data analysis.

Model 2:

$TQ = \beta_0 + \beta_1 GHG + \beta_2 BC + \beta_3 SIZ\ E + \beta_4 ROA + \beta_5 LEV + \beta_6 PPE + \beta_7 GROWTH + \beta_8 CASH + \beta_9 MTB + e$

Model Summary

Model	R	Adjusted R^2	Std. error	Change Statistic					Durbin-Watson
				R^2 change	F Change	df1	df2	Sig. F	
1	0.773	0.598	0.510	3.856	0.598	9	41	0.000	2.012

Source: Authors' own data analysis.

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	906.385	9	100.709	6.772	0.000
	Residual	609.772	41	14.872		
	Total	**1,516.157**	**50**			

ANOVA = Analysis of Variance.
Source: Authors' own data analysis.

Coefficients

Model		Unstandardised Coefficients		Standardised Coefficients Beta	t	Sig.
		B	Std. error			
1	(Constant)	7.875	4.581		1.719	0.093
	bc	0.028	0.046	0.066	0.619	0.539
	size	-3.502E-11	0.000	-0.0234	-2.163	0.036
	roa	3.466	4.082	0.088	0.849	0.401
	lev	-9.433	3.124	-0.510	-3.019	0.004
	mtb	0.247	0.047	0.599	5.288	0.000
	ppe	1.044	1.489	0.076	0.701	0.487
	growth	6.524	2.033	0.521	3.209	0.003
	cash	-0.849	0.639	-0.153	-1.329	0.191
	log_ghg	-0.003	0.106	-0.003	-0.030	0.976

Source: Authors' own data analysis.

Residual Statistics

Item	Minimum	Maximum	Mean	Std. deviation	N
Predicted value	-4.81	22.77	2.39	4.258	51
Residual	-9.006	16.227	0.000	3.492	51
Std. predicted value	-1.692	4.787	0.000	1.000	51
Std. residual	-2.335	4.208	0.000	0.906	51

Source: Authors' own data analysis.

Coefficients (Stepwise)

Model		Unstandardised coefficients		Standardised Coefficients Beta	t	Sig.
		B	Std. error			
1	(Constant)	0.567	0.672		0.844	0.403
	mtb	0.265	0.045	0.643	5.884	0.000
2	(Constant)	1.070	0.681		1.572	0.123
	mtb	0.287	0.044	0.697	6.488	0.000
	size	-3.6994E-11	0.000	-0.247	-2.298	0.026

Source: Authors' own data analysis.

3. Analysis on the influence of gender composition (GENDER) on carbon performance

Model 1:

$GHG = \beta_0 + \beta_1 GENDER + \beta_2 SIZ\ E + \beta_3 ROA + \beta_4 LEV + \beta_5 MTB + \beta_6 PPE + \beta_7 GROWTH + \beta_8 CASH + e$

Model Summary

Model	R	R^2	Adjusted R^2	Std. error	Change Statistic					Durbin-Watson
					R^2 change	F change	df1	df2	Sig. F	
1	0.449	0.201	0.049	5.613	0.201	1.324	8	42	0.258	2.234

Source: Authors' own data analysis.

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	333.766	8	41.721	1.324	0.258
	Residual	1,323.528	42	31.513		
	Total	**1,657.294**	**50**			

ANOVA = Analysis of Variance.
Source: Authors' own data analysis.

Coefficients

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.
		B	Std. error	Beta		
1	(Constant)	9.794	3.984		2.458	0.018
	size	2.733E-11	0.000	0.174	1.143	0.259
	roa	4.171	5.952	0.101	0.701	0.487
	lev	-0.544	4.547	-0.028	-0.120	0.905
	mtb	-0.006	0.069	-0.014	-0.090	0.929
	ppe	3.056	2.082	0.213	1.468	0.150
	growth	0.513	2.930	0.039	0.175	0.862
	cash	1.883	0.886	0.325	2.125	0.040
	gender	0.193	1.744	0.017	0.110	0.913

Source: Authors' own data analysis.

Residual Statistics

Item	Minimum	Maximum	Mean	Std. deviation	N
Predicted Value	8.843	18.554	11.639	2.584	51
Residual	-15.988	12.722	0.000	5.145	51
Std. Predicted Value	-1.082	2.676	0.000	1.000	51
Std. Residual	-2.848	2.266	0.000	0.917	51

Source: Authors' own data analysis.

Coefficients (Stepwise)

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.
		B	Std. error	Beta		
1	(Constant)	10.358	0.928		11.159	0.000
	cash	1.921	0.781	0.331	2.459	0.018

Source: Authors' own data analysis.

Model 2:

$TQ = \beta_0 + \beta_1 GHG + \beta_2 GENDER + \beta_3 SIZ\ E + \beta_4 ROA + \beta_5 LEV + \beta_6 PPE + \beta_7 GROWTH + \beta_8 CASH + \beta_9 MTB + e$

Model Summary

Model	R	R^2	Adjusted R^2	Std. error	Change statistic					Durbin-Watson
					R^2 change	F change	df1	df2	Sig. F	
1	0.771	0.595	0.506	3.870	0.595	6.695	9	41	0.000	2.029

Source: Authors' own data analysis.

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	902.212	9	100.246	6.695	0.000
	Residual	613.944	41	14.974		
	Total	**1,516.157**	**50**			

ANOVA = Analysis of Variance.
Source: Authors' own data analysis.

Coefficients

Model		Unstandardised Coefficients		Standardised Coefficients Beta	t	Sig.
		B	Std. error			
1	(Constant)	10.224	20937		3.481	0.001
	size	-3.152E-11	0.000	-0.211	-1.890	0.066
	roa	3.382	4.127	0.086	0.820	0.417
	lev	-9.496	3.135	-0.513	-3.029	0.004
	mtb	0.242	0.047	0.588	5.105	0.000
	ppe	1.182	1.472	0.086	0.803	0.426
	growth	6.768	2.021	0.541	3.350	0.002
	cash	-0.752	0.643	-0.136	-1.170	0.249
	gender	-0.384	1.203	-0.034	-0.319	0.751
	log_ghg	-0.001	0.106	-0.001	-0.010	0.992

Source: Authors' own data analysis.

Residual Statistics

Item	Minimum	Maximum	Mean	Std. deviation	N
Predicted value	-4.87	22.63	2.39	4.248	51
Residual	-9.801	16.365	0.000	3.504	51
Std. predicted value	-1.711	4.765	0.000	1.000	51
Std. residual	-2.533	4.229	0.000	0.906	51

Source: Authors' own data analysis.

Coefficients (Stepwise)

Model		Unstandardised Coefficients		Standardised Coefficients Beta	t	Sig.
		B	Std. error			
1	(Constant)	0.567	0.672		0.844	0.403
	mtb	0.265	0.045	0.643	5.884	0.000
2	(Constant)	1.070	0.681		1.572	0.123
	mtb	0.287	0.044	0.697	6.488	0.000
	size	-3.6994E-11	0.000	-0.247	-2.298	0.026

Source: Authors' own data analysis.

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