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Greenhouse Gas Mitigation Action Plans: An Assessment of Disclosure Practices among Malaysian Listed Companies

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ABSTRACT

This study investigates the disclosure of corporate greenhouse gas (GHG) mitigation action plans within the annual and sustainability reports of Malaysia's 100 largest companies from 2016 to 2019. Employing content analysis, we assess the varying degrees of integration and alignment of these strategies. Our findings reveal a notable improvement in the disclosure of GHG emission reduction action plans throughout the reporting period, evident in both the increased number of reporting companies and the enhanced quality of information provided. However, a significant challenge identified is the lack of standardized guidelines and frameworks for measuring diverse GHG emission reduction strategies and initiatives. This research enhances the existing literature on corporate GHG disclosure by offering granular insights into the reporting practices of Malaysian companies. We emphasize the critical need for greater consistency in GHG reporting and recommend further studies to fully comprehend the influence of different methodologies on public policy and investment decisions. Ultimately, this paper highlights Malaysian companies' efforts in GHG emission reduction and proposes strategies to bridge current gaps in mitigation and adaptation disclosure.

1. Introduction

Climate change has caused significant damage by increasing extreme weather events, rising sea levels and disrupting ecosystems and human life, affecting health, food systems and communities. Due to the detrimental effects of climate change or global warming, the phenomenon of climate change has been recognised as one of the most important environmental issues of the 21st century [1,2]. Due to increasing industrialization and urbanization, industrial activities have led to an increase in greenhouse gas (GHG) emissions in the atmosphere [3]. There is growing concern that companies

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are causing environmental damage through the consumption of fossil fuels for energy production, transportation, industry and deforestation [4,5]. Accordingly, the IPCC [7] reports that human behaviour and activities are the main causes of global warming, which is attracting increasing attention worldwide. Energy production, transportation, manufacturing and other operational activities release significant amounts of carbon emissions into the atmosphere, and the significant role of business in environmental degradation has been recognized.

The industrial growth of most countries is dependent on fossil fuel consumption, which leads to significant GHG emissions into the atmosphere [6,7]. Businesses, from local to multinational companies, contribute significantly to GHG emissions. The earth's temperature has been increasing, leading to global warming and climate change. However, corporate responsibility does not only extend to fossil fuel producers and power generators with direct industrial emissions. Previous studies classify liability for climate impacts in different sectors of the business world according to both narrow direct emissions from own facilities and broader indirect emissions that include impacts on the supply chain and product use [6,8].

As companies are an important part of society, they are expected to play an important role in stabilizing climate change by taking environmental issues into account in their business planning. Indeed, much attention has been paid to business practises and their contribution to the effects of climate change through climate change mitigation measures by reducing GHG emissions, even if they are not major emitters of GHG emissions [9]. The negative effects of climate change will worsen if no countermeasures are taken. In addition, environmental issues may affect the demand for non-financial information linking companies' performance on environmental issues and strategies [10,11]. Therefore, companies need to realign their reporting systems to create a web of mutual accountability and fulfil the needs of stakeholders, not just shareholders.

Given the complexity of environmental issues such as climate change, it is likely that these issues will have an impact on the profitability, success or even survival of companies. Therefore, it is no longer appropriate to assume that the company can continue to operate as usual, as it is quite unlikely that the company can make profits and increase shareholder value without considering the impact of climate change [12]. Therefore, companies are encouraged to assess, monitor and manage their activities related to climate change, including the mitigation of GHG emissions, and incorporate this into the evaluation of their financial performance as well as long-term market prospects [13].

Numerous companies from various industries have now recognised that they need to address climate change in order to ensure their survival and growth in increasingly complex business ecosystems [14-16]. In response to increasing pressure from various stakeholders, companies are currently pursuing various strategies to reduce their carbon emissions [14]. This strategy has been developed in response to concerns about climate change, which has led governments, the public, stakeholders and businesses to consider possible solutions to reduce GHG emissions [15]. However, the extent to which companies report and disclose strategies associated with their commitment to reduce carbon emissions remains unclear and inadequate.

Our research objective is to identify the plan and strategies of emission reduction initiatives in corporate sustainability reports to show the organization's progress in reducing GHG emissions. In addition, this study examines the type of GHG emission reduction initiatives reported by companies according to the Carbon Disclosure Project (CDP) Climate Change 2020 Reporting Guidance classification initiative. This study makes an important contribution to the literature on GHG emissions disclosure strategies in several ways. First, our study adds to the literature on emission reduction strategies from the annual reports of Malaysian listed companies [17,18]. Second, the types of carbon emission reduction initiatives were identified in line with CDP reporting guidelines based on details of initiatives implemented in the reporting years. Third, our research findings have

practical implications as they help investors and other stakeholders to better evaluate emissions reduction initiatives in the context of corporate reporting.

The structure of this paper is as follows: Section 2 defines the concept of GHG emission mitigation strategy. Sections 3 and 4 detail the methodology and present the results, respectively. The paper concludes in Section 5 with a comprehensive discussion and conclusion.

2. Literature Review

Malaysia has consistently demonstrated its commitment to global climate action, even prior to the 2015 Paris Agreement. In 2009, then-Prime Minister Najib Razak announced at the United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen where Malaysia's pledge to reduce carbon emissions by 40% from 2005 levels by 2020 (Susskind et al., 2020). Building on this, Malaysia updated its Nationally Determined Contribution (NDC) under the Paris Agreement, committing to an ambitious 45% reduction in economy-wide carbon intensity (as a percentage of GDP) from 2005 levels by 2030 [19]. This updated NDC further strengthens the initial 2015 commitment [20].

It is crucial to note that Malaysia's commitment to reducing carbon intensity per unit of GDP, rather than an absolute reduction, implies that total GHG emissions could still increase with economic growth. This measurement strategy underscores the inherent challenge Malaysia faces: balancing the imperative of reducing global GHG emissions with the demands of rapid economic development. As a developing nation, Malaysia navigates the complex task of decarbonizing its energy-centric economy amidst pressures from population growth and persistent poverty [21].

Energy Malaysia's 2017 report shows that from 1990 to 2016, more than 90 per cent of the electricity generated in Peninsular Malaysia came from fossil fuels [22]. During this period, Malaysia's economy has rapidly developed into one of the most competitive in Asia, featuring prominent landmarks such as the PETRONAS Twin Towers, Kuala Lumpur International Airport (KLIA), Light Rail Transit (LRT), SMART tunnel system and the new Mass Rapid Transit (MRT). In addition, the construction of high-rise buildings and apartments in major cities such as Kuala Lumpur, Penang and Johor Bahru are increasing rapidly [22].

Energy plays an important role in achieving Malaysia's sustainable growth and development goals [23]. The driving factor for development progress is conventional fossil fuels (coal, natural gas, diesel and fuel oil), which account for the majority of GHG emissions [24]. Malaysia is heavily dependent on fossil fuels such as coal and natural gas for energy use. According to 2017 Energy Commission data, 82.9 percent of Malaysia's energy mix consisted of fossil fuels, including 44.2 percent coal, 38.0 percent natural gas and 0.6 percent fuel oil/diesel. The remaining 17.1 is generated from renewable energy sources, mainly hydropower [22].

Given the importance of fossil fuels to the Malaysian economy, the commitments to decarbonization represent a significant undertaking. However, the limits of decarbonization in Malaysia are not particularly large compared to other comparable developing countries, many of which have made similarly ambitious pledges to reduce carbon emissions [21]. Malaysia urgently needs to consider an energy transition towards renewable energy sources, including solar energy, hydropower and biomass.

In Malaysia, there is currently no specific law that prescribes a reduction in GHG emissions. However, the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) has entered into a four-year collaboration with the United Kingdom since 16 May 2019 to assess the need for a climate change law and to draw on the United Kingdom its experience in passing its own climate change law in 2008. It was also reported that the Ministry of Environment and Water

(formerly MESTECC under the previous government) finalized the Climate Change Legal Framework in December 2021, which is intended to form the basis for a Climate Change Act that provides for the formation of a Climate Change Committee to ensure adaptation to climate change in the face of flooding, climate change mitigation and mechanisms to ensure compliance with existing laws.

As the latest government initiative, the Malaysian government has launched the twelfth Malaysia Plan, which sets out the national development strategy for 2021-2025. It reaffirms Malaysia's updated NDC target and conducts a feasibility study on carbon pricing, such as a carbon tax and an emissions trading scheme [25]. At the United Nations Climate Change Conference (COP26) in Glasgow, United Kingdom, the target of net zero emissions by 2050 was set. The development of proactive strategies on environmental issues and the explicit disclosure of information on carbon emissions have become essential for the company to meet stakeholder demands and maintain the company's image in developing markets, including Malaysia. However, given the importance of emission reduction initiatives in the context of climate change, there is not yet sufficient data to link the level of disclosure to uncertainty in carbon reporting in an emerging market.

3. Methodology

3.1 Sample and Data Collection

To capture the descriptions of GHG emission reduction strategies, this study relied on the annual and sustainability reports of the 100 largest non-financial companies listed on Bursa Malaysia from 2016 to 2019 (by market capitalization in 2016). The focus of this study on the 100 largest non-financial companies listed on Bursa Malaysia from 2016 to 2019 is justified by the expectation that these companies are more willing to participate in carbon disclosure due to their visibility, stakeholder pressure, and the potential political repercussions of non-disclosure [26,27]. This selection facilitates an extensive examination across multiple industries, emphasizing the influence of large firms in establishing norms for carbon reporting in Malaysia [28].

Focusing on the pivotal period from 2016 to 2019, this study provides a comprehensive analysis of climate change and sustainability disclosures in the annual and sustainability reports of selected Malaysian companies. This timeframe is strategically chosen for its significance, as it directly follows the landmark 2015 Paris Agreement and coincides with crucial reforms in Malaysian sustainability reporting frameworks. By examining corporate practices during these pre-pandemic years, this research seeks to establish a clear baseline of disclosure trends, mitigating the distorting influences that the subsequent COVID-19 pandemic might have had on corporate reporting. After excluding companies from the financial sector due to their specific regulatory requirements and removing companies with incomplete data, the final balanced sample consists of 94 companies from 10 industries, resulting in 376 firm-year observations.

3.2 Measurement and Data Analysis

Content analysis is the chosen methodology for this study. Krippendorff [29] defines content analysis as "a research technique for making replicable and valid inference from data according to their context". Its extensive application in the field of social and environmental reporting is well-documented [30-32], and it has similarly been employed to scrutinize corporate environmental strategies conveyed in annual reports [15]. A key advantage, as highlighted by Milne and Adler [30], is that the data yielded through content analysis can be quantified by deriving scales, thereby enhancing the method's objectivity and enabling robust statistical examination.

The PDF documents of the annual/sustainability reports were imported into the Atlas.ti software for qualitative analysis in order to identify descriptions for the disclosure of the GHG strategy. Based on the CDP Climate Change 2020 Reporting Guidance, a list of keywords for each category of initiatives was compiled in this study. The keywords were manually entered into the Atlas.ti software by category and company. Then Atlas.ti uses an algorithmic query to find all sentences containing these keywords and then counts the number of references to each category in the report in relation to the number of sentences. Only descriptions of emission reduction initiatives that were active in the reporting year, including those in the planning and/or implementation phase, were selected and coded. A manual review was performed to eliminate records that were not relevant to the category. The content analysis results have undergone review and validation by a certified mechanical engineer related to environmental expertise to confirm the accuracy of the coding.

4. Results and Discussion

Drawing on Kolk and Pinkse [33], a corporate climate change strategy is conceptualized as a series of deliberate actions executed over time to manage, and ideally diminish, a company's greenhouse gas (GHG) emissions. Consistent with Cadez and Czerny [18], "detailed plans or strategies to reduce GHG emissions" in this study specifically denote corporate initiatives that embrace alternative carbon practices. The selection of these mitigation strategies often varies significantly, contingent upon managerial strategic choices and available organizational resources [34]. Such strategic plans are typically reported in adherence to guidelines from organizations like the CDP and GRI. This conceptual grounding enables our study to provide an insightful overview of whether companies within our sample tend to focus on singular GHG reduction approaches or concurrently deploy a portfolio of strategies.

Table 1
Evidence of detailed plans or strategies and renewable sources

Year	Total companies	Detailed plans or strategies	
		Not Disclosed (%)	Disclosed (%)
2016	94	36	64
2017	94	21	79
2018	94	11	89
2019	94	14	86
Total	376	20	80

Table 1 shows that in 2016, more than half of the study sample (64 per cent) disclose plans and strategies to reduce GHG emissions, and this trend increases over the years until in 2019 the total number of companies disclosing this information is 86 per cent. The findings suggest that more and more companies are disclosing their plans and strategies to reduce GHG emissions. These results reflect those of Ooi and Amran [35], who also found that the majority of companies would disclose their business strategy in terms of GHG emissions reduction and carbon footprint due to global concern over climate change. Although the number of companies disclosing their data is slightly down in 2019, the scope and scale of disclosures is more significant.

The CDP Climate Change 2020 Reporting Guidance include a list of the main categories of initiatives, namely, energy efficiency in buildings, energy efficiency in production processes, waste reduction and material circularity, fugitive emissions reductions, low-carbon energy consumption, low-carbon energy generation, non-energy industrial process emissions reductions, company policy

or behavioural change. Table 2 shows an example of a statement explaining the plans or strategies to reduce GHG emissions or actions to address GHG emissions and categories of initiatives proposed by the CDP reporting guideline.

The energy efficiency of buildings and production processes is one of the most frequently reported initiatives compared to others. Companies are looking for ways to reduce energy consumption and emissions as a potential economic benefit lies in lowering operating and maintenance costs and optimising economic life cycle performance [36]. One possible explanation for this could be the increasing demand for energy in developing countries such as Malaysia, which has prompted many companies to step up their efforts to achieve a balance between energy production and consumption. These results are consistent with data obtained in Mustaffa *et al*., [37] who stated that from 2009 to 2019, various organizations in Malaysia have introduced some green building rating schemes including Green Real Estate (GreenRE), Malaysia Public Work Department Green Rating Scheme (pHJKR), Sustainability Index (SUSDEX), Malaysian Carbon Reduction and Environmental Sustainability Tool (MyCREST) and Sustainable Infrastructure Rating Tool (Sustainable INFRASTAR).

Behaviour changes strategies offer significant potential for transformative GHG emission reductions [38]; yet the majority of companies neglect to implement these strategies. To effectively reduce GHG emissions through corporate policies and behavioural changes, companies should develop strategies that encourage sustainable behaviour, educate employees about the consequences of their activities and promote an environmentally conscious culture. Furthermore, these strategies reduce traffic congestion and air pollution and minimize the space required for parking, while improving work-life balance and promoting health and fitness [38].

Low carbon energy consumption and low carbon energy production is often used to describe a corporate initiative that involves the use of energy sources and technologies that produce significantly less GHG, such as the transition to renewable energy consumption [40]. Renewable energy is defined as energy that comes from renewable, non-fossil sources that can be rapidly replenished through ecological cycles or agricultural activities (see GRI 302 Energy). Renewable energy sources include geothermal, wind, solar (including solar thermal and photovoltaic), hydropower and biomass. In addition, green energy is defined as coming from renewable resources that are naturally replenished, including sunlight, wind, rain, tides, plants, algae and geothermal heat [4].

This indicates that the disclosure of renewable energy strategies in Malaysia is increasing as the government has committed to creating renewable energy capacity by 2025 as outlined in the National Energy Transition Roadmap (NETR). Although this is an important step forward, the information disclosed on renewable energy strategies is not standardised, making it difficult for investors and stakeholders to compare companies' renewable energy efforts. Furthermore, the transition to low-carbon energy consumption is a complex and interconnected process that involves scientific, political and social interactions [40].

Table 2
Corporate GHG mitigation strategies and actions

Initiatives Categories	*Guideline from CDP Report*	*Statement from Annual/Sustainability Report*	*Sources*
Energy efficiency in production processes	Energy efficiency initiatives relating to buildings, including building fabric (e.g. insulation, draught-proofing) and building services (e.g. HVAC, BEMS).	To ensure optimal and effective consumption of natural gas, the operations team consistently monitors the running of the boiler system, which is already on an efficiently running Direct Control Combustion Control system. Our efforts on the same have resulted in a 3% reduction on the usage of natural gas in the Company.	Dutch Lady Milk Industries Berhad, 2017 Annual Report
Energy efficiency in buildings	Energy efficiency initiatives relating to processes (e.g. waste heat recovery, process optimization, compressed air, combined heat and power, automation, smart control systems, product/service design).	To improve energy efficiency and reduce our carbon footprint, we adopted green building features such as optimising natural light in the construction of our new building and replaced studio lights with low-energy light-emitting diode (LED) bulbs within our facilities.	Astro, 2018 Annual Report
Low-carbon energy generation	Initiatives relating to the installation of low-carbon energy generating facilities (renewable, nuclear or fossil-fuel plants fitted with carbon capture and storage) at your own site or at others on behalf of your clients.	For energy conservation and reduction in the use of fossil fuels, plant equipment designed with inherent waste heat recovery to generate steam is used. We have invested in dual-fuel boiler which burns hydrogen gas (generated in production as a by-product) for steam generation. Reducing use of fuel and reducing carbon emissions by using cleaner fuels will continue to be a focus.	Batu Kawan Berhad, 2017 Annual Report
Transportation	"Initiatives relating to employee travel and commuting and the company fleet"	(1) Introduction of the use of hybrid & EEV vehicles for company usage to reduce carbon emission. (2) Implementation of Telematics System to all company vehicles to monitor fuel consumption and driver driving vehicles to achieve fuel efficiency and reduce idling which would cause higher carbon emission.	British American Tobacco, 2018 Annual Report
Waste reduction and material circularity	"Circular economy and waste reduction initiatives (e.g. reuse, recycling, remanufacturing, product/service design to reduce waste etc.)"	We target to lower GHG emissions at our Mambong integrated plant by using more cementitious material in cement production and have plans in later years for the production of Portland Limestone Cement (PLC) and Blended Cement using silica fume and iron slag. Longer-term initiatives shall include reviewing raw materials, processes and types of finished products. In 2012, we implemented an upgrading project that made an investment into a high-momentum low NOx kiln burner.	CMSB, 2018 Sustainability Report

Table 2 (***Continued***)

Initiatives Categories	*Guideline from CDP Report*	*Statement from Annual/Sustainability Report*	*Sources*
Fugitive emissions reductions	Initiatives to reduce fugitive emissions (e.g. methane capture, agricultural nitrous oxide reductions, refrigerant leakage reduction).	We capture and utilise the methane gas released from our wastewater anaerobic treatment facilities at our mills. To date, we have progressively installed and now operate 25 biogas plants in our mills - the largest number of biogas plants held by a single plantation company in the world - and have successfully utilised the captured methane for rural electrification and as grid-connected electricity supply under our renewable energy projects.	FGV, 2017 Annual Integrated Report
Non-energy industrial process emissions reductions	Initiatives to reduce emissions from industrial production processes which chemically or physically transform materials (e.g. CO_2 from the calcinations step in cement manufacturing, CO_2 from catalytic cracking in petrochemical processing, PFC emissions from aluminium smelting).	The Plantation Division estates have utilised organic fertilisers produced through composting plants across Malaysia, mainly from POME and empty fruit bunch (EFB). To date, the Group has a total of 22 composting plants. Last year alone, 167,178 tonnes of CO_2-e was prevented from being released to atmosphere as a result of these initiatives.	Sime Darby, 2016 Annual Report
Low-carbon energy consumption	Emissions reduction initiatives relating to increasing low-carbon energy consumption i.e. energy from renewable sources, nuclear plants and fossil-fuel plants fitted with carbon capture and storage.	We use natural gas as the primary fuel in our plants as it is readily accessible and cleaner than other fossil fuels. In power generation, natural gas emits about 50 percent less carbon dioxide (CO_2) than coal, and negligible amounts of sulphur dioxide (SOX), nitrogen oxides (NOx), mercury and particulates. Even though natural gas is already the cleaner option, we make every effort to reduce our energy consumption in order to minimise our carbon footprint lowest possible.	Petronas Chemicals, 2019 Integrated Report
Company policy or behavioural change	Initiatives relating to a change in company policy (e.g. value chain engagement, a new procurement policy) or an organizational behavioral change (e.g. resource efficiency improvements such as reducing paper use, waste management improvements such as reducing food waste)	We take into account the good environmental practices when placing orders and assist the suppliers understand our purchasing policy through suppliers purchasing charters and on-site visits and audit.	ATA IMS 2018

Conversely, Malaysian public companies report less frequently on other types of mitigation initiatives, such as waste reduction, material circularity, non-energy industrial processes, and the reduction of fugitive emissions. This aligns with existing literature suggesting that the inherent uncertainties in estimating emission reductions, particularly for fugitive emissions, likely contribute to this lower reporting frequency [41,42]. Hence, sustainability disclosure frameworks suggest that guidance on disclosure of circular economic issues including waste and resource management

processes, is largely absent [43]. Thus, the findings reported here suggest that the disclosure of these types of initiatives is mostly inconsistent and largely unquantified.

The most important result was that measuring the quality and comprehensiveness of these disclosures presents significant challenges due to the lack of standardised guidelines and frameworks. There are some companies that provide detailed strategies in mitigating GHG emissions data with specific reduction targets, others offer only general statements about sustainability without actionable metrics resulting data lacks comparability and often transparency. In the absence of standardised terminology, organizations may use different terms for similar initiatives or identical terms for fundamentally different approaches. This makes it difficult to accurately categorize and measure the completeness of disclosures in the annual reports. For example, carbon capture and storage initiatives can be classified into established emission reduction categories, specifically whether they belong to "emission reductions from non-energy industrial processes" or "fugitive emissions reductions." This lack of clarity in the categorisation represents a significant obstacle for this study in the precise evaluation and grouping of companies' climate mitigation strategies. The lack of categorisation of initiatives makes it difficult to assess whether a company is pursuing a comprehensive strategy to reduce emissions or is only focusing on certain initiatives and ignoring others. Hence, it also makes it difficult to understand the industry-wide trends or best practices in developing strategies to reduce GHG emissions.

5. Conclusion

Malaysian companies have shown that they are willing to reduce their GHG emissions to meet the demand for more sustainable practices [44]. The commitment to net zero emissions must be followed by clearly defined actions and actionable strategies to set a concrete benchmark that demonstrates meaningful progress that can be thoroughly measured and evaluated [15,18]. This assumption is based on the premise that disclosure allows companies to better understand a problem while requiring them to disclose their action plan to reduce GHG emissions. Instead, their renewable energy strategies motivate them to take action to minimize these emissions. Another important finding is that some companies are beginning to provide details of the initiatives they have taken in their reporting, but there is still much room for improvement. One of the proposals under the CDP (2020) is for companies to report on initiatives at different stages of development. For example: "under review", "under implementation", "started implementation", " implemented" or "not implemented" to show the progress of the initiatives.

The analysis of this study yields several key conclusions. Firstly, our findings demonstrate that companies are employing diverse strategies and initiatives to reduce greenhouse gas (GHG) emissions. Secondly, the comprehensiveness of disclosure notably improved over the study period, with companies progressing from basic reporting to detailed documentation of specific targets, methodologies, and measured results. Thirdly, the increased disclosure of renewable energy as a GHG reduction strategy aligns well with the broader imperative of promoting sustainable and clean energy for future generations.

This study significantly contributes to the existing literature on greenhouse gas (GHG) emissions disclosure by specifically examining corporate GHG emission reduction action plans and renewable energy strategies within the Malaysian context. Our findings demonstrate the extent to which Malaysian public listed companies adopt various initiatives, often reflecting the guidance provided by frameworks such as the CDP. Furthermore, this research offers initial insights into how companies can better meet stakeholder needs and enhance GHG emission disclosure within their respective industries. The results strongly support the argument that companies, particularly those above a

certain size or operating in emission-intensive sectors, require more stringent guidelines and reporting frameworks. These frameworks should include clear guidance, standardized metrics, and robust verification requirements to ensure consistent and reliable disclosure.

Despite these contributions, this study has several limitations. Given its qualitative nature, the analysis focuses on general GHG emission reduction plans and renewable energy strategies, precluding specific quantification of mitigation measures. Future research could, therefore, aim to specifically quantify the types of mitigation measures and initiative plans. Additionally, employing a larger sample size would facilitate more comprehensive comparisons of GHG activities across a wider range of companies.

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