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Research Article

A Conceptual Paper on CO2 Emissions Management in Malaysia Food Industry

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ABSTRACT

The rising of population and food consumption create challenges to meet the growing demand with the limited water, energy and land resources. In a near future, climate change will affect agriculture and cause natural resources going into scarcity. Thus, it is critical to scrutinize the Malaysia domestic system that could support decision-making to practice sustainability. The main drivers behind this research are the agriculture industry is closely related to the basic needs of humans and the agricultural demands for human consumption are foreseen to be exceeded the supply in the near future. While striving to fulfill the demand of this generation, it is crucial for the food industries to find out a resolution to achieve a balance in juggling the demand, as well as environmental protection and greenhouse gas emissions. There are numerous empirical studies pinpointed the existence of government initiatives act as a catalyst to stimulate the involvement of industry players to work on greenhouse gas reduction aspirations. Even though the studies of greenhouse gas emissions have been adopted rapidly recently, however studies have shown limited understanding toward CO2 emissions management from the organization view, especially food industry in Malaysia. Hence, the study for greater industry-specific research on agriculture industry is absolutely essential. This research aims to provide an examination interaction between agriculture industry operation and the CO2 emissions management in food industry. Furthermore, this study will examine the effect of "government initiatives" as a moderator to the relationship between the "agriculture industry operation", and "CO2 emissions management" in Malaysia's food industry. The expected findings of this study will be useful to organizations in the food industry and other business organizations to learn about the factors to be emphasized to cut down CO2 emissions for alleviating climate evolution. The study could provide insights on the practical recommendations that can be applied by industries to address the challenges related to CO2 emissions and climate change.

Keywords: Agriculture Industry Operation, CO2 Emissions, Food Industry, Government Initiative

INTRODUCTION

Today, greenhouse gas emissions is built around the planet we live on. The heats trapped inside the atmosphere leads to global warming and resulted in climate change. Climate models anticipated that fire weather will become more frequent and intense under future warming, and at an increasing rate with each additional increment of warming. Ultimately, weather conditions affects plantation and food growth (Jones, 2022). Climate change has been the most major environmental issue, creating various economic, social, and ecological impacts worldwide over the past decades. The rise of industry globalization, economic development, increase population, and financial development have resulted CO2 emissions continue to increase. The inclination in CO2 emissions is considered the main reason of climate change and global warming issue today (Rahman & Alam, 2022). Technology revolution brings benefits to industrialization and economic growth. On the other hand, it causes some irretrievable damage to the environment and results in climate change. The global population is rising extremely, climate change will affect agriculture, cause natural resources going into scarcity, and eventually violate the basic human rights (McDonnell, 2020). On account

of the fact, under the Paris Agreement's worldwide climate change aim, many countries have pledged to reduce human environmental impacts and attain carbon neutrality by the mid-21st century (Ou et al., 2024).

An United Stated study revealed that food processing and supply distribution are part of the largest contributors to climate evolution, and food loss from the whole food chain exasperate issue. (Qin & Horvath, 2022) In fact, a vast array of historical, natural philosophy, social, cultural and political environments factors in agriculture emanates divergent form of farm characteristic, in term of its capacity, structure, activities, productivity, processing methods and etc (Sumberg et al., 2022). Another case study data built from the meteorological station Malaysia, Department of Statistics Malaysia and World Development Indicators confirmed that temperature and electricity consumption are significantly affect rice, coffee and vegetable production negatively. Furthermore, temperature, electricity usage, specifically fossil fuel consumption exhibited a negative and significant influence on agriculture value added, which is food further processed or manufacturing industry. Overall, these findings are strongly supported the adverse effect of climate change on various agricultural products in Malaysia (Akhtar & Masud, 2022). According to a previous study conducted in Vietnam, if the policies were put into place, environmental sustainability may be attained through lower emissions. Using sustainable energy sources, promoting technological advancements, supporting climate-conscious agriculture, together with supporting prudent forest management are a few of the strategies (Raihan et al., 2024). Nevertheless, an example from Wuwei, Northwest China, revealed that agriculture in Wuwei continues to be a carbon source even after optimization (Wu et al., 2025). This ascertain an earnest and insistent necessity to look into the important influences in agriculture industry operation that impacting CO_2 management in Malaysia food industry. It is also vital to analyze the features of the agriculture industry operation, including the social and behavioral science elements. This will assist the research to pin down the factors influencing the implementation of CO_2 emissions management.

LITERATURE REVIEW

CO_2 Emissions in Food Sector in related to Agricultural Industry

The reason of concentrating in the agriculture industry is because past researchers have conducted the CO_2 related study in other countries. The past results demonstrated a sturdy connectivity between CO_2 emissions and agriculture sector. In particular, the studies from the past researchers strongly proven that the agricultural is one of the main drivers causes the increase in CO_2 emissions. A case study in Bangladesh revealed that agricultural economic, energy structure and emissions factor are accountable for the decrease of CO_2 emissions (Hossain & Chen, 2022). Besides that, a study in Brazil also proven CO_2 emissions associated with a thorough set of agricultural products in the the country, where an estimated 911 Metric tons of CO_2 associated with agriculture in 2019, 81% of that associated with planted pastures according to their recent study (Danilo, 2022). Organizational size and environmental volatility have a significant impact on the adoption of Hybrid Project Management in FinTech Malaysia and sustainability in Quality 4.0 (Tan et al., 2023). This draws the attention of this research to excavate in specific on the agriculture industry, as well as organization perspectives.

A research in India has proven a ozone pollution has significantly caused the reduction in crop productivity globally. The wheat crop in the green revolution belt is strongly affected by air pollutants compared to climate crisis, which poses food security not only at regional level but also globally (Kaur, 2022). As a consequences, supporting a circular bio-economy is imperative for the food sectors today to accommodate and feed more than 9 billion of people in 2050 later while boosting the United Nations Sustainable Development Goals (Duarte et al., 2022). Human and most of the living organism rely on crop as one of our energy sources. When the agriculture food production is not on par with the population growth, it will form a scarcity situation. Worst of all, the constant surge in greenhouse gas emissions is likely to jeopardize agriculture productivity. Ultimately, it will post imminence threat to all the lifeforms on earth.

Previous study indicated food supply chains had outstripped farm gate processes to become the biggest greenhouse gas component of agri-food systems emissions in 2019 with 2.2 Gt CO_2eq. It is also projected to increase more than half to 3.5 Gt CO_2eq in the following years which becoming greater than emissions from land-use change. This has important reverberations for food relevant industries to look into the national mitigation strategies, considering mainly on decreasing of non-CO_2 gases within the farm gate and on carbon dioxide alleviation from land use change (Tubiello et al., 2022). The priority of CO_2 emissions in the agriculture food industry is crucial and it required more attention as it is the main cause of greenhouse gas emissions that caused climate change situation.

According to the results of an analysis of the causes reducing greenhouse gas emissions in Saudi Arabia, the number of people who use the internet, percentages of population growth, GDP growth, and forest rents are all important factors that affect carbon oxide emissions (Guermazi et al., 2025). This research assists policymakers in Saudi Arabia and around the world in identifying factors that moderate GHG emissions and designing targeted responses appropriately. To shift to a low carbon society, policymakers, businessman, finance and civil organizations stakeholders are increasingly attentive to develop future emissions pathways and associate closely to physical climate risks which will potentially emanating from increasing temperatures. Researchers forecast transition risks situation in 2030, where the risks are associated to temperature pathways arises from economy mitigation costs, carbon cost increases, decrease in fossil fuel demand and coal plant capacity. Whereas in 2050, physical risks will stemming from serious heatwaves, drought, heat stress and decrease in crop duration (George et al., 2022). At Sierra Leoneon SSF, the best strategy to maintain low CO2 emissions is to prioritize food and income security. In other words, food security and CO2 reductions are complementary rather than antagonistic (Okeke et al., 2024). This added tension in the food industry and it accelerate the global attention on the development of CO2 emissions in the agriculture food industry.

Problem Statement

In the Asia-Pacific Disaster Report 2019, droughts found to be the severe disaster from the climate change and it has continued to affect millions of people in Southeast Asia countries. The record from 2011 to 2020 showed Cambodia, Indonesia, the Lao People's Democratic Republic, and Malaysia have the large numbers of people affected by droughts (United Nations, 2022). This ascertain the direction of this paper to examine the CO2 emission management in Malaysia, as greenhouse gas emission is the root cause of climate change that caused the emerge of natural disasters.

Southeast Asian countries are prone to exposed to quick temperature rises and abrupt changes in rainfall patterns, which tend to caused land degradation and crop failures. In the last 20 years, there were more than 50 natural disasters occurred in Malaysia, which have threaten the lives and livelihood, particularly those in the agriculture sector. The economy in Malaysia sustained a total damage of about RM8 billion due to major floods and dry spells from 1998 to 2018 (Bank Negara Malaysia, 2020). This emphasized the seriousness of the situation in the country. It prompted the necessity of researchers to look into CO2 emissions management in Malaysia and propose possible solutions to mitigate climate change.

The past studies revealed that the adverse weather phenomenon is projected to be more volatile amid the rise in global warming. This ascertained that agricultural and food supply disruptions issue will only be more frequent and severe in the future if no precautions steps are taken today. The performance of the Asia Pacific countries analyzed varies significantly across the The Agricultural Growth Enabling Index (AGEI), the results found some common relative strengths and weaknesses. For instance, Malaysia's government found willing to spends on public services, such as research & development in agricultural field, land stewardship on the rights and access, financial support to farmer, the existence and quality of agricultural infrastructure, compared to other Southeast Asian countries (OECD, 2017). With the advent of the digital era, new funding channels that are easier for financially strapped businesses to access are being made possible by technology-driven fundraising systems. Nevertheless, the significance of these new mechanisms in promoting environmental, social, and governance practices among micro, small, and medium-sized businesses is still unknown because Malaysia is still in the early stages of their development (Ong et al., 2024). The COVID-19 epidemic caused a record drop in global CO2 emissions. Some studies suggested utilizing the COVID-19 recovery plans to advance the climate agenda at the same time is seen as a calculated move to guarantee a sustainable future for the post-pandemic world (Nguyen et al., 2025). It is always advised to take necessary precautions before a negative situation happens. Thus, it is worthy to investigate the causes of CO2 emission management in Malaysia's agriculture industry in specific.

Significant of study

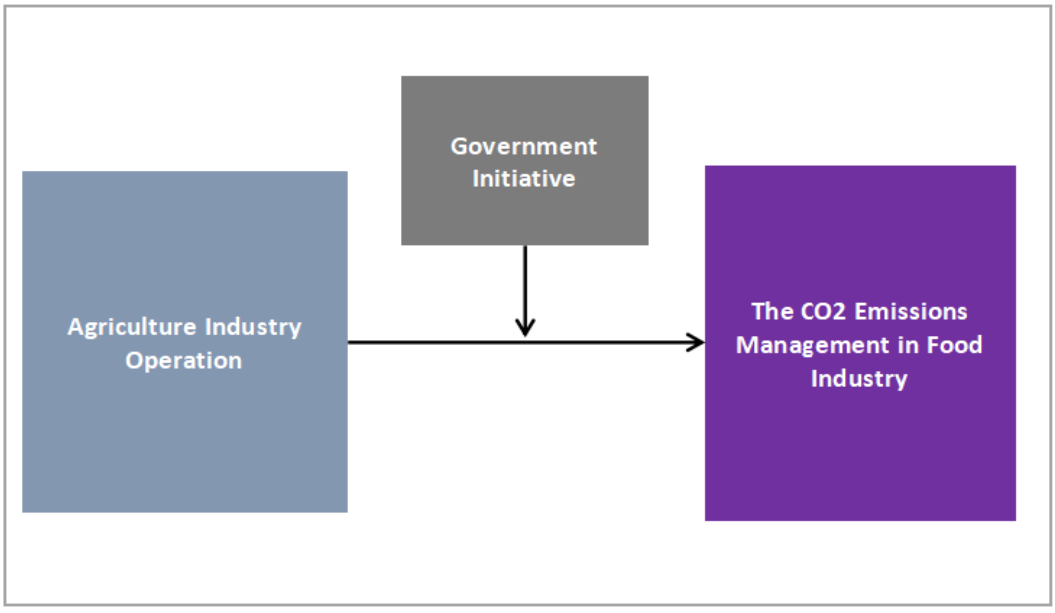
CO2 emissions are found to be positively interconnected with economic growth in the short term. However, these emissions in fact has a little impact on development of economy in a long run. CO2 emission rise at the beginning of economic development, but eventually it grows slow as time pass by. Due to the complication of the correlation between CO2 emissions, urbanization that resulted from economic development, local government shall be more vigilant in regional governance, especially in economic and urban planning and design, diversity in consideration,

and adhere to circular, green and low-carbon development (Zhang et al., 2022). Furthermore, according to a previous study in Pakistan, it suggested policymakers should encourage more financial investment in greener technology and digitization, and the government should also think twice on its energy mix and prioritize alternative electricity sources (Wei et al., 2024). Generally, the factors affecting the CO2 emission management is vague and circumlocutory in some ways. Thus, it is critical to scrutinize rigorously from different perspectives.

In the analytic forecast, power sector emissions is anticipated to remain around the same energy level from 2021 to 2024. In reality, to meet the Net Zero Emissions forecast by 2050, it has to start declining sharply. Today's policy settings are still insufficient to reduce greenhouse gas emissions. Therefore, massive changes is essential to drive the reduction. For instance, to de-carbonizing the huge power grids system, the changes in energy efficiency and low carbon supply for the electricity sector are both vital and necessity. Based on the studies, the electricity demand growth across the region is driven by both industrial development and the growth in utilization and electrification of cooling, cooking and mobility. Notwithstanding renewable energy helps to fulfill a big portion of the new demand and resulted in carbon emissions intensity reduction, but the total emissions still grow significantly (IEA, 2022).

Global industrialized countries had set ambitious on climate targets yet they acknowledged the challenge of existing mechanisms for CO2 pricing are insufficient to help them attain the expected sustainability ambition. In this multi-faceted electricity market model, it includes expansion in solar grid system and electricity trading. There are also diverse policy approaches to restraint emissions by gradually get rid of emission-intensive technologies, investing on renewable energy, or limiting CO2 pricing (Grimm et al., 2022). There is contradiction between the success elements for sustainable development and sustainable entrepreneurship, despite some research defining sustainable entrepreneurship as a business model founded on the United Nations' Sustainable Development Goals (Sithambalam et al., 2024). Some study proven parallel initiatives focusing on accelerating forest protection can help reduce agricultural GHG emissions while also promoting climate-smart farming practices and sustainable agricultural expansion (Li et al., 2025). Despite many countries and companies are embarking their sustainability journey by committing to the Net Zero Emissions target in 2050, the industry is lacking of a structure and concrete plan to drive this sustainability effort. This is one of the critical factors that deceleration the pace in pursuing the net zero pathway. According to Qiaoyang & Talib (2024), Malaysia is one of the top 10 countries with the highest citation count within the ESG field. This ascertained the direction of this paper to scrutinize in Malaysia context.

Theoretical Framework



"Agriculture" involves a wide variety of historical, biophysical, social, cultural and political environments factors which resulted in a difference way of farm characteristic, in term of its capacity, structure, activities, productivity, processing methods and etc (Sumberg et al., 2022).

"Industrial" is referring to the manufacturing business (Kähkönen & Lintukangas, 2022). In this context, we will be focusing on food industry in specific.

"Operation" implies all activities involved in the process which facilitate the consumers and it is among the key activities that relate to the organization (Rahman & Moin, 2022).

"Agriculture and food industry" is representing the largest goods producing in the value chain (Grimsby & Kure, 2019).

"Government initiative" includes strategic human resources management and financial management. Besides that, it also involved decentralization, transparency, and economic growth. The agreement is established on an equilibrium of the interests of political forces and the competing benefits (Alberts et al., 2021).

"CO2 emission" stand for carbon dioxide emission. It means the emission of carbon in the atmosphere resulting from activities that are linked to human activities or others. CO2 emission is identified as one of the greenhouse gas emission, which induced climate change disrupts human and nature balance. Production companies are one of the key factors causing CO2 emissions (Dincer et al., 2022).

Agriculture Industry Operation

The triple bottom line theory, also called TBL categorized sustainability into three pillars: economic, social, and environmental. The TBL is known as a concept for measuring a company's overall achievement based on its contributions to economic progress, social accountability, and environmental quality, as written by the European Commission. The existence of green economy is to minimize the threats of depleting available resources for both present and future generations. The United Nations Environment Program (UNEP) exemplified the green economy concept will help to improve social equity by reducing ecological imbalance and environmental risks. Furthermore, the establishing a green economy ensures the coexistence of society and nature. Today, the TBL theory is still broadly adopted by different business organizations (Chang et al., 2023). Therefore, this study intend to find out more from the environmental perspective of the TBL model, especially on the impacts of agriculture.

In addition, TBL model is a holistic treatment is needed that satisfies all stakeholders through a high level of operational performance, which provides economic prosperity, environmental protection, and social integrity. It provide the systems for collecting and interpreting data, so that the complexity of TBL does not create an impasse, overloading managers seeking to carry out reforms. In brief, adopting enterprise systems will benefit the three dimensions of TBL and the company's performance, motivating companies to adopt sustainable practices in letter and spirit. The performance of companies depends on their planning and positioning in society and the market (Nogueira et al., 2023). This ascertained it is worthy to scrutinize on how agriculture operation make impact on CO2 emissions management.

Hypothesis 1 : There is a significant interaction between agriculture industry operation and the CO2 emissions management in food industry.

Government Initiatives

Environmental degradation evoked the governments' awareness and foster them to take up an aggressive role in protecting our environments and earth. In most cases, many governments often mediates the private enterprises in running a business by introducing many different forms of environmental regulations and business incentives. The purpose of developing and implementing these regulations is to reduce greenhouse gas emissions that will contribute to climate change. Energy efficiency regulations are created with intention to reduce unnecessary energy consumption, the regulations covers the directives of Eco-design and how to manufacture using energy-efficient processes. The past study revealed that government intervention had a positive impact on the organization's environmental innovation and technological innovation capabilities (Joo & Min, 2022).

Moreover, it is also found that small and medium enterprises' reaction to government intervention is mediating the effect between government intervention and the organization performance. This finding demonstrated the ecological modernization and institutional theories. In the past study, both Korean and Chinese governments have made deliberate attempt to assure the positive influences of the organization environmental performance on their bottom line. Those efforts are such as, dynamic support of governments in promoting environmental sustainability and encouraging the organizations to adopt green supply chain management (GSCM) principles with absolute support

and attractive incentives. The organization is susceptible by the external institutional pressures, this includes government rules and regulations. The organization is likely to comply with the government induced environmental regulations. In addition, the organization will make extra effort to improve their environmental and innovation capabilities in order to increase the chance for their legitimacy and secure market competitiveness. The logic behind this institutional theory is when an organization is heavily dependent upon government environments in a high uncertainty situation, the adoption of institutionally accepted practices, shared values, or organizational structures can ensure the organization's survival with a greater legitimacy Environmental performance. In brief, it is referred to as the extent of the organization's ability to deliver eco-friendly products to meet customer specific requirement and the government's environmental standards (Joo & Min, 2022).

Hypothesis 2: There is an effect of government initiative moderating the relationship between agriculture industry operation and CO2 emissions management in the food industry.

METHODOLOGY

In this case study, the research is designed by quantitative methods and analyzed by descriptive and explanatory methods. The purpose of adopting descriptive analysis is to provide the analysis of some external relations matters and the relationship between population quantity. Whereas the explanatory analysis is to reveal the internal relations of things and the relationship between explanatory variables. Moreover, we use positivism as a conceptual framework for research rather than interpretivist approach. We developed the hypothesis testing and followed a probabilistic way to analyse thing objectively because we believe the empirical nature to study facts.

The unit of analysis is focus on the organization. The population of this study is concentrated in agriculture industry. To obtain a complete and all-inclusive list of the food industry population in the Malaysian context, we have conducted extensive research on the legitimate platform in the country, which can provide an unambiguous and updated list of the food industry players. In this research, we adopted the food manufacturing company list from the list of certified companies under the Veterinary Health Mark (VHM), which is a legitimate platform that approved agriculture companies for the domestic and export markets. The VHM list is issued by the Department of Veterinary Services (DVS) Malaysia.

CONCLUSION

The study is planned to conduct through a quantitative approach, panel data analysis. The study will evaluate whether the main hypothesis of the research project has a significant positive correlation between agriculture industry operation, government initiatives and CO2 emissions management. This will help to provide useful recommendations to look at the potential factors to be on attention in alleviating climate change. The primary hypothesis will be verified based on each sub-hypothesis and through this verification process, it will help to reveal if the main hypothesis is applicable. This research is designed to provide a better insight into the practical implementation of CO2 emissions in food industry in Malaysia context to support sustainable development.

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