Original Research Article
Response of Construction Industry to Carbon Neutrality: A Case Study on Taiwan, Thailand, and Japan

ABSTRACT

Large-scale emissions of greenhouse gases have contributed to global warming, leading to extreme weather events worldwide and posing a serious threat to human survival. Carbon dioxide is the primary greenhouse gas contributing to this phenomenon. The United Nations Intergovernmental Panel on Climate Change has established a global consensus on reducing greenhouse gas emissions to achieve carbon neutrality. This study focused on the construction industry, a major contributor to carbon emissions, by exploring the strategies and business models employed by construction companies in three Asian countries to achieve carbon neutrality. This study aimed to explore the current state of the construction industry in both developed (Japan) and developing (Taiwan and Thailand) countries in Asia by analyzing the following: their progress toward net-zero emissions; the implementation of environmental, social, and governance criteria policy; and the alignment with the United Nations' Sustainable Development Goals. Specifically, this study examined how the construction industries in these countries promote carbon neutrality when implementing construction projects while simultaneously contributing to environmental and social welfare to enhance long-term corporate competitiveness. Overall, environmental, social, and governance performance has become a crucial global standard for corporate investment evaluation.

Keywords: Construction industry; net-zero emissions target; environmental; social, and governance (ESG); sustainable development goals (SDGs)

1. INTRODUCTION

1.1 Research Background and Motivation

Global warming and climate change have increased the frequency and intensity of extreme weather events, such as heavy rainfall, hurricanes, droughts, and earthquakes, which pose a major threat to safety. In 1980, the International Union for Conservation of Nature introduced the concept of sustainable development, calling for global attention to the environmental crisis affecting the planet. The World Commission on Environment and Development further advanced this cause in 1987 by proposing strategies for sustainable human development, which raised global awareness on relevant issues. During the 1997 Third Conference of the Parties to the United Nations Framework Convention on Climate Change held in Kyoto, Japan, an agreement was finally established to regulate greenhouse gas emissions.

The Kyoto Protocol aims to curb greenhouse gas emissions to prevent the worsening of global climate conditions by targeting key gases such as carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. With nations beginning to consider energy conservation and carbon reduction measures for mitigating global warming, the United Nations has urged both developed and developing countries to actively promote sustainable development. The construction industry, which accounts for 38% of global annual carbon dioxide emissions, is a major contributor to carbon emissions. Therefore, the present study explored how the construction industry can respond to the

challenge of reducing carbon emissions and achieving carbon neutrality by implementing sustainable construction practices in a green economy.

1.2Research Objective

The construction industry is an integrated sector that encompasses the entire construction process from the extraction of raw materials to the final stages of property management. This comprehensive scope of operation causes the industry to contribute approximately 40% of total global carbon dioxide emissions. The reality of global climate warming is indisputable, and the United Nations' Sustainable Development Goals (SDGs) formed the focal point of the present study. From the perspective of construction project implementation, relevant environmental indicators should be developed in accordance with each country's green building assessment standards [1], and sustainable business reports published by construction companies should be reviewed to analyze their strategies for reducing carbon emissions. Such strategies include constructing low-energy, environmentally friendly buildings and evaluating the effectiveness of construction industries in various countries in achieving the 17 SDGs.

1.3Research Scope

The present study focused on the construction phase of building projects. A comparative analysis was performed on three countries: Japan, a developed country ranked 3rd in the 2023 World Economic Rankings, and Taiwan and Thailand, developing countries ranked 21st and 27th, respectively. The analysis centered on their strategies and progress toward achieving the 2050 net-zero emissions target as well as their alignment with environmental, social, and governance (ESG) criteria and the SDGs.

2. INTRODUCTION TO THE CONSTRUCTION INDUSTRY

2.1 Evolution of Carbon Neutrality Endeavors in the Construction Industry

Characterized by its labor-intensive nature, the construction industry is a traditional sector that spans both industrial and commercial activities. Because of the various processes involved in construction projects, the industry's carbon dioxide emissions are higher than those of other sectors. According to the United Nations Environment Programme, the construction industry accounts for approximately 40% of global greenhouse gas emissions [2,3]. Furthermore, with the continuous growth of the global population, energy consumption is projected to increase by up to 53% over the next decade [4], inevitably leading to increased greenhouse gas emissions.

Carbon emissions associated with buildings stem from the energy consumed during the operation of air conditioning, lighting, and other systems [5], as well as from energy losses during the demolition, construction, and maintenance of buildings. In addition, the transportation of building materials contributes to carbon dioxide emissions [6]. Relevant statistics indicate that the construction industry must undergo a thorough transformation by implementing emission reduction strategies to achieve carbon neutrality by mid-century, as outlined in the Paris Agreement for 2050 [7].

The United Nations Intergovernmental Panel on Climate Change has set a unified pathway that requires a reduction of building carbon emissions by 80%–90% by 2050, with new buildings being nearly fossil fuel–free and zero-energy [5]. To this end, the World Green Building Council has established two key targets for the construction industry.

1. By 2030, all new buildings should achieve net-zero carbon operations.

2. Strategies focusing on low carbon intensity should be prioritized over those for promoting carbon offsets to ensure that all buildings achieve net-zero carbon operations by 2050 [8].

In response to the aforementioned targets, scholars and industry experts have collaboratively developed building energy standards and certifications aimed at reducing energy use and greenhouse gas emissions [9]. Although the demand for carbon-neutral buildings continues to increase, decision makers must now address relevant challenges and take concrete actions that will result in substantial and sustainable effects on carbon reduction efforts [10,11]. Building construction is a complex task that requires ongoing decision-making regarding new energy, emerging technologies, and various economic and environmental considerations [12,13].

Evaluating decarbonization strategies adopted in individual building projects to achieve carbon neutrality is essential for promoting the optimal strategies across the entire construction industry. However, standard guidelines have not been established for different local environments in the construction of carbon-neutral buildings [14]. The RIBA Plan of Work framework provides a globally recognized guideline [15] for each phase of a building project, from the initial report, design, and construction to the operation of the project [16]. Therefore, the framework can be referenced to create guidelines for constructing green buildings. In addition, analysis of new energy can be incorporated to promote carbon neutrality and formulate strategic solutions, thereby achieving optimal operational performance for buildings.

2.2Characteristics of Construction Industry

The term “specialized construction industry” incorporates the activity of construction companies that focus on specific fields or specialized techniques. These companies possess expertise and skills in specific areas, enabling them to deliver high-quality professional construction services and solutions [17]. They have a unique understanding of quality, which they define as meeting the specific needs of their clients. Accordingly, companies must design product specifications with the customer’s perspective in mind [18]. In this context, specialized techniques are directly related to the safety of residential structures. In addition, the integration of new energy and technologies to address the effects of carbon neutrality is a prevailing trend, and the construction industry plays a crucial role in carbon reduction. The present study first explored the elements that constitute the construction industry across various countries, the regulations governing the establishment of construction companies, the differentiation among these companies, and the strategies they have adopted to pursue carbon emission reduction and carbon neutrality as operational goals.

2.3Introduction to Construction Industries in Taiwan, Thailand, and Japan

In Taiwan, construction companies are categorized into Classes A, B, and C on the basis of their capabilities and qualifications. In Thailand, construction companies must meet specific criteria, including being legally established entities with the primary purpose of conducting construction business. These companies must have stable and sufficient financial resources, employ certified engineers, and possess their own tools, machinery, and construction equipment. In Japan, construction companies must possess construction permits to engage in construction activities. These permits are classified as special construction permits and general construction permits.

The scope of business for the construction industries in Taiwan, Thailand, and Japan varies depending on the scale and demands of each country and region. Market segmentation can be effectively conducted to develop new markets at the national level, arrange cross-region investments, and promote global expansion [19].

2.4Research on Carbon Neutrality in the Construction Industry

Amid global efforts to reduce carbon emissions and achieve net-zero emissions by 2050, the construction industries in Japan, Thailand, Taiwan, and other Asia-Pacific countries are implementing national strategies with a strong focus on low-carbon futures. Research on carbon neutrality in the global construction industry has identified several key technological measures currently being adopted during the construction phase:

1. Improving energy efficiency: This measure entails upgrading equipment and introducing new technologies.

2. Energy and resource recovery: This measure involves implementing waste heat recovery, solid waste management, and material recycling.

3. Renewable energy: This measure entails adopting solar energy, energy storage systems, microgrids, new energy, hydrogen energy, and biomass energy.

4. Carbon offsetting: This measure involves engaging in forest carbon sequestration; carbon trading; and carbon capture, utilization, and storage.

The construction industry continues to adapt to technological advancements by incorporating new concepts and technologies [20]. The management philosophy of the industry has evolved to embrace a global perspective, where implementing environmental protection through energy conservation and carbon reduction has become a key international trend. Moreover, alignment with government initiatives for carbon reduction and net-zero emissions ensures that the management of the construction industry can meet contemporary requirements for environmental preservation. The present study explored how the construction industries in Taiwan, Thailand, and Japan address the 17 SDGs and examined the trends in corporate sustainable construction, sustainability reporting, and development of ESG practices.

3. ANALYSIS OF CARBON NEUTRALITY RESPONSE IN CONSTRUCTION INDUSTRIES OF TAIWAN, THAILAND, AND JAPAN

3.1 Cross-Comparison Analysis of Sustainability Reports from Construction Industries in Taiwan, Thailand, and Japan in Response to National Policies

In Taiwan, the construction industry is actively promoting strategies that align with the government's goal of achieving net-zero emissions by 2050. The government's comprehensive plan for achieving the aforementioned goal outlines four major transitions: energy transition, industrial transition, lifestyle transition, and social transition, all supported by technological research and development and climate legislation. To meet these policy objectives, companies are required to integrate low-carbon technologies during the construction process, enhance the efficiency of new energy applications, and adopt renewable energy.

In Thailand, the construction industry is actively promoting strategies that align with the government's goal of achieving net-zero emissions by 2065. These strategies include energy transition initiatives, such as the installation of solar rooftops and electric vehicle charging stations in future construction projects. The industry is also committed to achieving 100% solar rooftop coverage in all residential construction projects within the next few years. Carbon reduction policies are being implemented across the entire value chain, including green procurement, green building design, and green construction practices. Additionally, companies are investing in environmental and construction technologies and collaborating with multiple partners to design and construct low-energy and low-carbon residential buildings. These strategies demonstrate that the Thai construction industry is not only meeting the government's 2065 target but is also advancing carbon neutrality within a short timeframe, striving to become a pioneer in net-zero emissions among Thai industries.

Among the various industries in Japan, the construction industry is the first to align itself fully with its government's goal of achieving net-zero emissions by 2050. Detailed strategies and long-term goals have already been established to fulfill its commitment to carbon neutrality by 2050.

These findings indicate that construction companies in Taiwan, Thailand, and Japan have all taken proactive measures and, to varying degrees, have aligned with their respective national net-zero emission policies.

4. CROSS-COMPARISON ANALYSIS OF SUSTAINABILITY REPORTS AND CARBON NEUTRAL PRACTICES DURING CONSTRUCTION PHASES IN TAIWAN, THAILAND, AND JAPAN

A cross-comparison analysis of sustainability reports and carbon neutrality practices in construction industries of Taiwan, Thailand, and Japan was conducted. Its results indicated that, to achieve similar success that of Japanese construction companies in implementing the SDGs, Taiwanese and Thai companies could enhance their practices by adopting the following strategies and measures.

4.1 Formulation of Clear Sustainable Development Strategies

1. Systematic planning: The Japanese construction industry has integrated the SDGs into its corporate strategies by establishing well-defined short-term, mid-term, and long-term goals. Taiwanese and Thai companies could learn from this approach by developing specific implementation plans for each SDG.

2. Departmental coordination: Companies should ensure that all departments understand and implement SDG-related goals to embed sustainable development into daily operations.

3. Implementation of innovative technologies and solutions: Japan has adopted various innovative technologies in building and urban planning to considerably reduce carbon emissions during construction processes [21] and create more environmentally friendly and efficient buildings. Although the construction industries in Taiwan and Thailand have adopted this model, there is still room for improvement in its practical application [22,23]. Technological innovation should be a core driver for achieving the SDGs.

4. Promotion of green design and construction: Companies should promote the use of renewable energy, energy-saving technologies, and green building materials to reduce carbon emissions and mitigate environmental effects.

4.2Establishment of Strong Partnerships

1. Cross-departmental collaboration: The Japanese construction industry collaborates with various government agencies, nongovernmental organizations, and academic institutions to achieve shared goals. Taiwanese and Thai companies could use this model as a reference to enhance resource, technology, and knowledge sharing through cross-sector collaboration, thereby achieving more favorable SDG implementation outcomes.

2. International collaboration: Companies should actively participate in international collaboration projects to learn from successful experiences abroad and localize those practices.

4.3Cross-Comparison Analysis of Construction Phases in Taiwan, Thailand, and Japan

The analysis results indicate the construction companies in the three countries have implemented new measures during the construction phase to address climate change problems. This effort reflects their concern for global environmental issues. These companies have actively participated in global climate action by improving building energy efficiency, using renewable energy, and reducing carbon footprints.

Overall, construction companies in Taiwan, Thailand, and Japan all recognize the importance of environmental protection, social responsibility, and sustainable economic growth, and they have been actively promoting these practices during the construction phase. Their collective efforts set a positive example for the construction industry, demonstrating how corporate governance can contribute positively to both environmental and social welfare while supporting economic growth. Notably, ESG performance has become a key global standard for corporate evaluation and investment. For the construction industry, integrating environmental responsibility, social responsibility, and corporate governance into every aspect of its operations is an essential task [24].

5. CONCLUSION AND FUTURE RESEARCH RECOMMENDATIONS

5.1 Conclusion

The Asia-Pacific region has been profoundly affected by climate change, pollution, environmental degradation, and unsustainable consumption and production practices. Each country must address the risks associated with the worsening global environment. Geopolitical dynamics have further exacerbated environmental and health crises, highlighting the importance of the net-zero mission for global sustainable development. Multiple countries have responded to various environmental challenges by establishing 2050 net-zero emissions as a key national objective.

The analysis of carbon neutrality practices implemented by construction industries in Taiwan, Thailand, and Japan revealed that achieving carbon neutrality has become a crucial common objective for the global construction industry. However, notable differences exist in the progress and strategies employed by different countries to achieve this goal [25]. As a developed nation, Japan leads in technological innovation, policy support, and corporate practices, providing valuable lessons for other countries.

Although Taiwan and Thailand have recognized the importance of carbon neutrality, they are still in the developmental stage of achieving net-zero emissions, with room for further improvement in the depth and scope of their implementation efforts [26,27]. The findings of this study suggest that an active transformation of the construction industry, coordinated with cross-industry interactions, is crucial for making a full contribution to environmental protection.

5.2Future Research Recommendations

The present study primarily employed qualitative analysis to explore and analyze the integration of carbon neutrality and ESG practices in the construction industries of Taiwan, Thailand, and Japan. Future scholars may consider adopting a case study design with quantitative research methods and further expand the research scope to include other Asian countries, such as South Korea, Malaysia, and Brunei. Surveys, statistical data analysis, and other methods can be employed to gain a broader perspective, which would help in identifying trends in policy implementation, corporate strategies, and market responses across various countries. Accordingly, more robust data can be acquired to support sustainable development in the Asia-Pacific region within a global development framework.

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