

The Carbon Emission and Sustainability of Manufacture for Better Carbon Efficiency

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Abstract

Taiwan is an export-focused manufacturing economy instead of a brand-marketing one. In other words, the manufacturing exporters in Taiwan are generally adopting supply chain management measures to secure orders. The upcoming implementation of the European Union's Carbon Border Adjustment Mechanism (CBAM) has caused carbon anxiety in Taiwanese manufacturers before it has been enforced. The emphasis on environmental conservation is a sign of progress; however, amid significant social change, businesses often feel pressure rather than seeing it as a positive development. Although the total amount of resources is still increasing, businesses have not yet fully adapted to the new society and businesses will tend to become agitated and anxious, even frantic. Unfortunately, this problem can not be resolved in the short term. The businesses can only focus on developing and adopting to meet the market. To maintain Taiwan's position in the global supply chain, it's essential to adapt and comply with the new international regulations. The first step is voluntary carbon disclosure to address carbon challenges. The purpose of this research is to investigate Taiwanese manufacturers' understanding of how voluntary disclosure to aid corporate decision-making.

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1. Introduction

1.1 Impact of Greenhouse Gases

In recent years, global climate change issues have garnered substantial attention. With greenhouse gas emissions being one of the primary causes, Taiwanese businesses need to address the carbon challenge and risk. It is essential for companies to fully comprehend the importance and value of greenhouse gas's negative impacts and take actions to control greenhouse emissions aiming for sustainable development.

Greenhouse gases are the gases in the atmosphere of the Earth that can absorb and re-emit radiation from the surface of the Earth, such as carbon dioxide (CO₂), methane CH₄, chlorofluorocarbons (CFCs), etc. These gases cause the average temperature of the Earth to rise and lead to global climate change and extreme climate. The primary greenhouse gas emissions are from human activities such as the production of energy, transportation, industrial manufacturing, etc.

Greenhouse emissions have caused severe damage to the environment and the future growth of economics. For instance, hurricanes, floods, and droughts pose significant threats to agriculture, fisheries, water resources, and ecosystem, and even endanger human activities. Greenhouse gas emissions also have negative impacts on future growth of the economics, such as rising the cost of energy, resource waste, and damage to corporate image. Furthermore, public concern about greenhouse gases is increasing and more relevant laws have begun to be gradually formulated. Therefore, corporations are facing increasing pressure to control greenhouse gas emissions.

1.2 Motivation and Purpose

As global climate change issues become increasingly severe, carbon reduction has emerged as a crucial topic worldwide. As key participants in economic activities, businesses play a significant role in carbon reduction efforts. Taiwan, being an export-oriented economy with small and medium-sized enterprises (SMEs) forming a crucial part of its economic structure, must confront international carbon reduction trends and requirements directly.

First, SMEs should conduct greenhouse gas inventories to understand the carbon emissions. Companies can utilize relevant greenhouse gas emission calculation methods and tools, such as carbon footprint assessment tools and carbon emission accounting standards, to measure greenhouse gas emissions. This allows businesses to understand the emission levels and sources, identify potential opportunities for carbon reduction, and set specific goals and measures for reducing carbon emissions. Second, energy management and audits are also essential for SMEs to understand the carbon reduction needs. Companies can engage in energy management and audits by monitoring and recording energy usage, analyzing energy consumption, and conducting energy audits to identify and quantify energy consumption, as well as pinpoint areas with higher energy usage. By understanding the energy usage, companies can develop corresponding energy-saving and carbon reduction plans.

In summary, understanding the carbon reduction needs of Taiwanese SMEs requires

a comprehensive approach that considers multiple perspectives, including greenhouse gas inventories, energy consumption data collection, carbon footprint assessments, industry standards, and best practices. By thoroughly understanding the carbon reduction needs, companies can formulate appropriate strategies and achieve sustainable economic and environmental benefits through the carbon reduction process.

1.3 Research Limitations

The issue of greenhouse gases is a relatively nascent topic in Taiwan, with familiarity limited to a small number of key personnel and practitioners. Consequently, conducting large-scale surveys is not feasible. Therefore, this study employs the expert interview method for its investigation.

2. Literature Review

2.1 Enterprise External Environment

The ISO 14064-1:2018 standard serves as a guideline for the quantification and reporting of greenhouse gas (GHG) emissions and removals at both the planning and organizational levels. It emphasizes the requirements for defining the boundaries of GHG emissions and removals, the quantification of these emissions and removals within organizational operations, and the identification of specific corporate actions aimed at improving GHG management (ISO, 2018).

In addition to the original specifications of the ISO 14064-1:2006 standard, the 2018 update incorporates the concept of a full life cycle, thereby broadening the scope of greenhouse gas management across the corporate value chain. This approach allows companies to manage GHGs from a supply chain value perspective, adopting a full life cycle viewpoint. By aligning with various management system standards' audit objectives, companies can establish a comprehensive sustainable development framework, helping the organization to achieve sustainability goals. Furthermore, the GHG inventory results from ISO 14064-1:2018 are closely aligned with other widely recognized international environmental standards, thus alleviating the regulatory burden on enterprises (Guan-Lin Lu & Yuh-Ming Lee, 2020).

2.2 Enterprise Internal Environment

Internalizing carbon costs involves incorporating the expenses associated with carbon emissions into the internal cost structures of companies or individuals, thereby holding them accountable for the negative impacts of the emissions. The advantage of this approach lies in its ability to incentivize companies and individuals to reduce carbon emissions, enhance carbon efficiency, and drive low-carbon development by increasing the financial burden associated with emissions. For businesses, the process of internalizing carbon costs requires addressing two key aspects. The first involves the monitoring and calculation of carbon emissions; companies must accurately assess the emission levels to determine the corresponding costs to bear. The second aspect pertains to the internal accounting

and allocation of these carbon costs within the organization.

Companies must integrate carbon costs into product pricing and service fees, thereby encouraging both employees and consumers to reduce emissions and contribute to low-carbon development. Across all industries, "green" has emerged as a dominant trend. Green products are not only safer for people and the planet but also often feature varying degrees of reusability, which helps in cost savings. However, the concept of "green companies" also prompts deeper reflection on the fundamental purpose of a company's existence (Hick, 2000).

2.3 Enterprise Internal Processes Management

Carbon taxes and carbon credits not only impact a company's profitability but also influence its product portfolio. As carbon pricing becomes a global trend, companies must proactively consider reducing the total carbon emissions throughout the production process rather than passively observing how taxes erode overall profits.

The establishment, maintenance, and continuous improvement of internal management systems are essential to ensuring that organizations follow a systematic approach to achieving ongoing performance enhancement (Heslin & Ochoa, 2008). This approach represents a pragmatic method for improving carbon efficiency, which is intrinsically linked to human behavior. The efficiency of carbon usage hinges on how energy is utilized and the awareness and choices made by individuals regarding energy consumption. For instance, as awareness of energy conservation and the adoption of renewable energy sources grows, people are likely to choose more environmentally friendly and efficient means of energy consumption, thereby improving carbon efficiency.

Moreover, carbon efficiency is closely related to lifestyle and consumption habits. High-carbon activities, such as frequent driving, meat consumption, and extensive travel, contribute to reduced carbon efficiency. In contrast, adopting low-carbon lifestyles, such as walking, cycling, and following a vegetarian diet, can significantly reduce carbon emissions and enhance carbon efficiency.

3. Methods of Data Collection

3.1 Expert Questionnaire Design and Dimensions

This section focuses on the critical success factors for voluntary GHG disclosure and how to effectively implement this disclosure within organizations. Building on literature research and studies on key factors, the aim is to identify the essential elements necessary to better understand the operational dynamics of organizations engaged in voluntary GHG disclosure.

The study primarily investigates the key factors influencing greenhouse gas self-disclosure within Taiwan's manufacturing industry, and how strategic management can facilitate the successful execution of greenhouse gas inventories in this sector. Drawing from literature research and studies specific to the manufacturing industry's self-disclosure of greenhouse gases in Taiwan, questionnaires and

interviews were conducted with corporate personnel and experts from public institutions. The objective was to determine the necessity of these factors, thereby gaining deeper insights into the critical elements for conducting greenhouse gas inventories in enterprises. The findings aim to serve as a reference for future practitioners concerning the key success factors.

3.2 Facet Instruction

This questionnaire survey targets personnel responsible for greenhouse gas inventories within the manufacturing industry, aiming to enhance the objectivity of the factors considered in the survey. The questionnaires were distributed exclusively to senior management personnel and experts from public institutions, with the goal of understanding the key factors that the manufacturing industry identifies as critical in this context. A total of 9 experts participated in this interview process. After collecting the questionnaires, the study sought to understand the experts' assessments of various influencing factors by using the research variables for observation and measurement. This study applies Lawshe's (1975) Content Validity Ratio (CVR) as the criterion for determining the importance of factors. The formula is as follows, with the judgment criteria presented in Table 1. Given the panel of 9 experts, a CVR value of 0.78 is used as the threshold for determining significance.

$$\text{CVR} = (\text{ne} - \text{N}/2) / (\text{N}/2).$$

N: Number of Experts.

ne: Number of Experts Considering the Factor Important.

Table 1: Expert Information

No. Panelists	Min Value*
5	.99
6	.99
7	.99
8	.75
9	.78
10	.62
11	.59
12	.56
13	.54
*Min. Value must exceed 0.78.	

4. Results Analysis and Discussion

In the context of the external environment for greenhouse gas disclosure, professionals face significant uncertainties, as shown in Table 2. No significant factors were identified. When dealing with carbon-related issues, companies predominantly adopt a wait-and-see approach, awaiting the establishment of clear standards. Consequently, the strategic orientation within the industry tends to be defensive, with businesses looking to emulate the successful models of early adopters before implementing the strategic responses.

Table 2: Enterprise External Environment

External Environment	Selected Important Experts	Result
Norm Adjustment, such as coefficients	8	Insignificant
Government policy support, encouraging self-inspection	6	Insignificant
Carbon fee levy, overseas & domestic	4	Insignificant
Environmental unit supervision strength	7	Insignificant
Progress of other industries' inspections	4	Insignificant
Change in inspection standards	2	Insignificant

As anxiety over carbon issues continues to rise, as reflected in Table 3, businesses are increasingly faced with severe challenges. It is widely acknowledged that companies have limited ability to influence the external environment, leaving them to adapt through internal adjustments. Consequently, within the internal environment dimension, only one factor remains significant: the proficiency of internal personnel in ISO-14064, identified by a working group as an important factor.

Table 3: Enterprise Internal Environment

Internal Environment	Selected Important Experts	Result
Identification of inspection organizational boundaries	8	Insignificant
Identification of baseline year for inspection	8	Insignificant
Confirmation of inspection purpose	7	Insignificant
Data collection on the intensity of corporate activities	7	Insignificant
Proficiency of internal personnel in ISO-14064 (group)	3	Insignificant
Proficiency of advisory consultants	9	Significant
Continuous carbon reduction planning after certification	5	Insignificant
Commitment of senior management	3	Insignificant

The advancement of management processes and information technology has significantly enhanced overall corporate productivity. To maintain high operational efficiency, internal organizational processes must be optimized. Managers are thus challenged to drive improvements across various internal processes, establish efficient management practices, and implement corresponding evaluation and feedback mechanisms. Consequently, the final internal process dimensions identified for companies include two significant factors: the execution of inspection inventories, practical manuals, and procedure documents, and the establishment of greenhouse gas inspection procedure documents.

Table 4: Enterprise Internal Processes Management

Internal Processes	Selected Important Experts	Result
Internal management capability of the enterprise	7	Insignificant
Economies of scale of products or processes	5	Insignificant
Financial capability of the enterprise	2	Insignificant
Execution of inspection inventories, practical manuals, and procedure documents	9	Significant
Establishment of greenhouse gas inspection procedure documents	9	Significant
Preparation of greenhouse gas emission reports	8	Insignificant
Completion of verification results	6	Insignificant
Identification of materiality assessment	7	Insignificant

5. Conclusion and Suggestions

Manufacturing industries experiencing carbon anxiety must focus on enhancing carbon efficiency to effectively address these challenges. But what exactly is carbon efficiency?

"Carbon efficiency" is a practical concept that refers to the efficiency with which energy is utilized in the production processes of an enterprise. During energy use, whether it involves fossil fuels or electricity, greenhouse gas emissions are inevitably generated. Therefore, improving energy utilization efficiency becomes a crucial strategy for effectively reducing these emissions. Moving forward, carbon efficiency is likely to be recognized as a key indicator in the effort to reduce carbon emissions, as it enables companies or organizations to lower their carbon footprint while simultaneously boosting production efficiency and optimizing resource utilization.

In this context, carbon efficiency should be viewed as a method or means to achieve the broader goal of net-zero carbon emissions. By enhancing carbon efficiency throughout both production and consumption processes, companies can reduce carbon emissions, thereby advancing closer to the net-zero carbon goal.

Improvements in carbon efficiency may encompass a range of measures, including refining production processes, optimizing energy usage, managing resources more effectively, innovating product design, and enhancing supply chain management. Achieving these improvements typically requires comprehensive management and continuous refinement within the organization.

What constitutes progress? It is the pursuit of a better life, achieving more through the simplest means - by increasing efficiency.

Thus, humanity bears a significant responsibility in the pursuit of enhanced carbon efficiency. We must deepen our understanding of energy and environmental issues, drive technological innovation, and advocate for supportive policies to achieve improvements in carbon efficiency, thereby contributing to both economic development and environmental protection.

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