International Multidisciplinary Research Journal
ISSN: 2424-7073
Available Online at https://imrjournal.info/
Volume: I; March 2025; Page No.1-10
DOI: https://doi.org/10.47722/imrj.2001.35

Research Article

EXPLORING KEY SUCCESS FACTORS FOR CARBON FOOTPRINT VERIFICATION IN LOGISTICS ENTERPRISES THROUGH STAKEHOLDER THEORY

Hsiang-Fa, Ling[1] ; Ching-Chiang Yeh[2]; Yi-Hsuan, Chen[3]

[1] *Dean and Associate Professor, Open College Affiliated with National Taipei University of Business, and Department of International Business, National Taipei University of Business, Taipei City,* Taiwan

[2]*Professor and Chairman, Department of Business Administration, Open College Affiliated with National Taipei University of Business, and Business Administration, National Taipei University of Business, Taipei City, Taiwan*

[3]*MBA, Department of Business Administration, National Taipei University of Business, Taipei City, Taiwan*

ARTICLE INFO

Article History:

Received 15.12.2024
Accepted 15.01.2025
Published 15.03.2025

Keywords:

environment, society and economy (ESG), carbon inventory, carbon footprint verification (CFV), Stakeholder theory, Stepwise Weight Assessment Ratio Analysis (SWARA)

ABSTRACT

As global awareness of environment, society and economy (ESG) issues rises, ESG has become a critical performance metric. Companies must emphasize environmental sustainability, social responsibility, and corporate governance to gain market recognition, making the adoption of ESG principles in the logistics industry essential. Accordingly, energy conservation and carbon reduction in the logistics and transportation sectors have emerged as key challenges. This study, grounded in stakeholder theory, develops an evaluation framework for identifying the factors that influence carbon inventory practices in logistics companies. The Step-wise Weight Assessment Ratio Analysis (SWARA) method is employed to assess and determine the weightings of various factors. The findings reveal that regulatory legislators are the most influential factor in carbon inventory initiatives within logistics companies. These results offer practical insights for logistics companies seeking to implement effective carbon inventory strategies in the future

1. Introduction

With the increasing global emphasis on environment, society and economy (ESG), ESG has become a critical performance metric for companies. To gain market recognition, businesses must prioritize environmental sustainability, social responsibility, and corporate governance. According to the International Energy Agency (IEA), the logistics and transportation sectors account for approximately 37% of global carbon dioxide emissions,

making them highly carbon-intensive industries (IEA, 2022). Moreover, the logistics industry is an important pillar of the global economy, accounting for approximately 10% of global GDP. The development of the carbon emissions for logistics industry has had a significant impact on the ESG (Kim et al. 2021; Lopes et al., 2021).

Given that understanding the sources of carbon emissions and establishing detailed carbon emissions, the carbon footprint verification (CFV) has become increasingly critical for logistics industry (Sun, 2017). CFV involves using specific methods and data collection to calculate GHG associated with products, companies, or countries. The objective of CFV is to offer a precise assessment of GHG emissions, facilitating efforts to reduce emissions over time and mitigate the impacts of climate change (Peng et al., 2024). It reassures regulators, customers, employees, shareholders, potential investors, environmental groups, the media and competitors, of the integrity, completeness and transparency of the carbon footprint calculations.

A thorough CFV enables logistics industry to gain a detailed understanding of their emissions profile and effectively manage carbon credits (Gallo, 2022). While some large logistics companies with greater resources have initiated carbon audits, many companies face substantial challenges due to limited resources and expertise in carbon inventory management. These constraints have resulted in delays or technological bottlenecks in implementing carbon audits.

According to statistics from the environmental protection administration, transportation accounted for 12.8% of Taiwan’s carbon emissions in 2019. As such, the transportation industry plays a key role in carbon reduction. Road transportation contributes 96.8% of total emissions within the transportation sector. Therefore, the global trend towards reducing greenhouse gas (GHG) emissions presents significant challenges for Taiwan's logistics industry. However, the previous studies in transportation carbon emissions research mainly focus on statistical analysis, life cycle assessment and model simulation (Fan et al., 2023).

The objective of this study is to investigate the key success factors in conducting CFV for logistics industry. First, drawing on stakeholder theory, the study will construct an evaluation framework to assess the factors influencing CFV in logistics firms. Subsequently, the multi-criteria decision-making (MCDM) approach will be proposed, incorporating the Stepwise Weight Assessment Ratio Analysis (SWARA) methodologies. The goal is to identify the critical success factors for CFV in the logistics sector and provide strategic decision-making guidance for logistics companies. Furthermore, this study provides an empirical case from Taiwan to demonstrate the practicality of the proposed approach.

The rest of the paper is organized as follows: Section 2 provides the literature review. Section 3 introduces the proposed methodology, while the MCDM is considered with a focus on the SWARA methods. Section 4 discusses the results and findings obtained. In the last section, the conclusion is made.

2. Literature review

2.1 Carbon footprint verification

Carbon footprint, sometimes referred to as the carbon audit, is an assessment and reporting methodology that allows organizations, buildings, and urban areas to more accurately

quantify carbon emissions and identify opportunities for enhancement (El Geneidy et al., 2021). Carbon footprint verification (CFV) (Xue et al., 2023) refers to the calculation of carbon footprints (carbon emissions) generated in all activities and can be divided into the organizational type (e.g., the entire enterprise) or product type. CFV aims to provide assurance that reported carbon footprint calculations are reliable and contributes to reducing greenhouse gas emissions, thereby mitigating the impact of climate change. Having independent verification of carbon footprint shows all stakeholders the organisation has a serious approach to environmental impact, and ongoing improvement.

Currently, the exploration of CF is in its early stages, lacking substantial advancements. There is an urgent need for further industrial practices to facilitate the development of CF methodologies. (Herold, 2018; Chen and Wu, 2022)

2.2 Stakeholder theory

Freeman (1984) introduced the "stakeholder theory," which posits that stakeholders are any groups or individuals who can affect or are affected by the achievement of an organization's objectives. This includes seven categories: government, competitors, customers, employees, civic groups, suppliers, and shareholders. The core principle of stakeholder theory is that businesses must balance the interests of different stakeholders while managing these relationships effectively. For a business to achieve sustainability, it must employ various strategies and actions to address the needs of diverse stakeholders.

Since the inception of stakeholder theory, scholars have continuously offered revisions and suggestions. For instance, Davis and Thompson (1994) argued that suppliers' influence is primarily evident in industries with close upstream and downstream relationships. Fassin (2008) identified two key issues: (1) the identification of stakeholders can lead to confusion, as individuals may simultaneously belong to multiple stakeholder groups—for example, an individual may be both a customer and an employee in a consumer goods company; (2) Freeman's model presents a business-centric, unidirectional relationship with stakeholders, yet in reality, these dimensions may influence each other. For instance, government policies can be shaped by consumer movements, and suppliers may be affected by governmental regulations, such as refusing to provide materials to companies lacking proper licenses (Shou et al., 2023).

Corporate stakeholders are resource investors upon which a company depends for its survival. They can be broadly categorized into three types: market environment resource investors, tangible and intangible resource investors, and intellectual and physical resource investors. Market environment resource investors primarily refer to national and local governments. Tangible and intangible resource investors provide economic resources to the company in the form of equity and debt, including monetary funds, physical assets, and industrial property. Intellectual and physical resource investors are employees who contribute their services through knowledge and labor. Correspondingly, these investors possess the right to demand compensation (Li et al., 2016).

From the perspective of organizational environment, Kinicki and Williams (2003) classify employees and board members as internal stakeholders of the organization. Jones et al. (2007) and Hill and Jones (1992) also differentiate stakeholders from internal and external perspectives, employing a similar classification approach. Jones identifies shareholders,

management, and general employees as internal stakeholders, while Hill and Jones regard shareholders, employees, managers, and board members as internal stakeholders. Regarding external stakeholders, Jones includes customers, suppliers, governments, labor unions, local communities, and the general public, while Hill and Jones argue that creditors should also be considered.

2.3 Discussion

Based on the literature review above, it is evident that the critical success factors for CFV have been explored less frequently in the past. Furthermore, this study synthesizes and summarizes the relevant literature on stakeholder theory and incorporates insights from interviews with logistics industry experts. The factors influencing the success of CFV in logistics companies are categorized into four major dimensions. The four dimensions include internal stakeholders, regulatory stakeholders, market stakeholders, and environmental stakeholders.

3. Method

The primary objective of this study is to explore the critical success factors for CFV in logistics companies. To accomplish this, the research first establishes the framework based on stakeholder theory to identify the factors influencing CFV. Subsequently, this study utilizes the Stepwise Weight Assessment Ratio Analysis (SWARA) method to determine the weights of the influencing factors. In the following section, we first present the foundational concepts of the proposed approach, followed by a detailed description of its steps.

3.1 Proposed approach

Based on the relevant literature on stakeholder theory, this study constructs four major dimensions as the framework, which serves as the foundation for the questionnaire design. In this study, the aim is to contribute not only to the MCDM literature, but also to practitioners so that logistics managers can make better decisions regarding for CFV.

3.2 Stepwise Weight Assessment Ratio Analysis (SWARA)

In alignment with the research framework established in this study, the Stepwise Weight Assessment Ratio Analysis (SWARA) method is employed for analysis. This method was introduced by Keršulienė et al. (2010). In this approach, experts play a vital role in evaluating and calculating weights. Each expert assesses the importance of each criterion, and the overall ranking of the expert group is determined by calculating the average ranking assigned by each expert to every criterion. Compared to other methods, SWARA offers a concise and accurate means of determining indicator weights. It has been widely applied across various fields, including sustainable renewable energy assessment, service quality evaluation, business location selection, and supply chain evaluation (Thakkar and Thakkar, 2021), only to the MCDM literature, but also to practitioners so that logistics managers can make better decisions regarding for CFV.

The procedural steps of the SWARA method are outlined as follows (Keršulienė et al. 2010; Thakkar and Thakkar, 2021):

Step 1: Ranking of the assessment factors.
Step 2: Determining relative importance s_j.
Beginning with the second factor, the jth factor is compared to the preceding $(j-1)$ th factor to ascertain relative importance, denoted by the symbol s_j.

Step 3: Determine the coefficient value k_j using the following Eq. (1):

$$k_j = \begin{cases} 1 & j = 1 \\ s_j + 1 & j > 1 \end{cases} \quad (1)$$

Step 4: Calculate the importance vector q_j as below Eq. (2):

$$q_j = \begin{cases} 1 & j = 1 \\ \dfrac{q_j - 1}{k_j} & j > 1 \end{cases} \quad (2)$$

Step 5: Calculate the relative weights of the assessment factors w_j as Eq. (3):

$$w_j = \frac{q_j}{\sum_{k=1}^{n} q_k} \quad (3)$$

Step 6: Finally, following the above steps, the arithmetic average of the weight values from each expert is calculated to derive the final weight values, which are then ranked.

4. Results and discussion

4.1 Data collection

A key aspect of this study is the selection of experts. To enhance the credibility of the respondents, personal interviews—conducted either in person or over the phone—were utilized to ensure the questions were comprehensively understood. The participants include upper management professionals, all of whom have more than five years of experience in the logistics sector. Detailed demographic information about the respondents can be found in Table 1. The following section will analyze and explain the variations in the significance of factors affecting CFV, taking gender and job title into account.

Table 1 Background information of experts

Category	Items	No.
Gender	Male	56
	Female	24
Job Title	First-line management	43
	Mid-level management	27
	Top-level management	10

4.2 Using the SWARA method for determining weights

To assess the importance of factors influencing CFV, this study applies the SWARA method for weight analysis in this section. Weights and relative importance of each factor and sum will be calculated in this section.

Table 2 presents the calculations of the weights for the four dimensions using the SWARA method. In this table, experts express the relative importance of the *j*th dimension in relation to the ($j-1$) th dimension, which allows for the estimation of the comparative importance represented by the average value (s_j). Subsequently, using Eqs. (1) and (2), the coefficients (k_j) and the recalculated weights (q_j) are derived. Finally, the relative weights of the dimensions are computed using Eq. (3). The analysis reveals that, based on the established preference order, regulatory stakeholders (B) hold the highest priority weight, followed by internal stakeholders (A), while market stakeholders (C) represent the least important dimension.

Table 2 Final results of SWARA method in weighting dimension

Dimension	s_j	k_j	q_j	w_j
Internal stakeholders (A)	0.5857	1.4246	0.5920	0.2585
Regulatory stakeholders (B)	0.6038	1.3774	0.6695	0.2926
Market stakeholders (C)	0.5796	1.5144	0.4916	0.2128
Environmental stakeholders (D)	0.5656	1.4313	0.5429	0.2361

4.3 Comparison among the opinions from different categories

Similarly, table 3 shows the analysis of dimensions conducted using the same steps, which has been carried out by the top-level management, mid-level management and first-line management. This study generates three sets of factor prioritizations based on the respondents' opinions. The final results, as presented in Table 3, indicate the rankings of these factors, it shown that regulatory stakeholders (B) (0.2926) serve as the most important factor, followed by internal stakeholders (A) (0.2585), environmental stakeholders (D) (0.2361), and market stakeholders (C) (0.2128).

Table 3 Final results of SWARA method in weighting by job title

Dimension	**Local weights**							
	First-line management	**Rank**	**Mid-level management**	**Rank**	**Top-level management**	**Rank**	**Synthesized**	**Rank**
Internal stakeholders (A)	0.2596	2	0.2509	2	0.2740	2	0.2585	2
Regulatory stakeholders (B)	0.2845	1	0.2947	1	0.3217	1	0.2926	1
Market stakeholders (C)	0.2017	4	0.2222	4	0.2351	3	0.2128	4
Environmental stakeholders (D)	0.2541	3	0.2321	3	0.1692	4	0.2361	3

As illustrated in Table 3, all parties expressed varying perspectives regarding the importance of the different factors across their respective dimensions. According to the top-level management, the regulatory stakeholders (B) (0.3141) as the leading factor, followed by internal stakeholders (A) (0.2509), environmental stakeholders (D) (0.2278) and market stakeholders (C) (02.351). However, mid-level management and first-line management take

regulatory stakeholders (B) as the most important factor, with a higher priority than that of internal stakeholders (A) and environmental stakeholders (D), market stakeholders (C) is relatively less important.

Similarly, the analysis of criteria was conducted using the same steps, which has been carried out by different gender and the final results are presented in Table 4.

Table 4 Final results of SWARA method in weighting by gender

Dimension	Male	Rank	Female	Rank	Synthesized	Rank
Internal stakeholders (A)	0.2618	2	0.2509	2	0.2585	2
Regulatory stakeholders (B)	0.2834	1	0.3141	1	0.2926	1
Market stakeholders (C)	0.2064	4	0.2278	3	0.2128	4
Environmental stakeholders (D)	0.2484	3	0.2073	4	0.2361	3

As shown in Table 4, all parties also offered distinct viewpoints regarding the importance of the various factors according to their respective dimensions. Among these factors, the priorities of the regulatory stakeholders (B) and internal stakeholders (A) are similar to each other. However, the market stakeholders (C) and environmental stakeholders (D) are different views upon the importance.

4.4 Discussion

Following the development of the integrated framework, the analysis of the MCDM model using SWARA, and the collection of data from 80 senior executives, this study identifies the key factors influencing the CFV. According to the results based on comprehensive evaluations, we see that regulatory stakeholders (B) (0.2926) is the most important factor, followed by internal stakeholders (A) (0.135), environmental stakeholders (D) (0.2361), and market stakeholders (C) (0.2128).

The three management levels recognize that regulatory stakeholders (B) is the most important factor, and followed by internal stakeholders (A) is the second. They acknowledge the unique characteristics of carbon inventory and the risks associated with conducting CFV, yet they hold varying opinions on the third and fourth key factors. The top-level management considers market stakeholders (C) (0.2128) as more important than environmental stakeholders (D) (0.2361), whereas the first-line management and mid-level management hold the opposing viewpoint.

Moreover, among these factors, the priorities of the regulatory stakeholders (B) and internal stakeholders (A) are similar to by different gender. However, the market stakeholders (C) and environmental stakeholders (D) are different views upon the importance.

Based upon these results, this study offers a valuable reference for conducting carbon inventories through the effective allocation and coordination of various resources.

5. Conclusion

The factors influencing CFV within the logistics industry remains an area of ongoing inquiry. This study makes significant contributions in three key aspects. First, it integrates

stakeholder theory within the CFV context to elucidate the complexities of CFV implementation. Additionally, we propose a novel research framework tailored to the logistics industry in Taiwan, specifically addressing the challenges associated with CFV implementation. Second, our framework, coupled with the SWARA method, facilitates the analysis and illustration of the relative weights of various factors influencing CFV. The findings from this analysis enable us to assess the feasibility of CFV from multiple expert perspectives. Notably, our results indicate that different experts prioritize distinct concerns regarding CFV implementation, which can be attributed to specific dimensions of the logistics sector. Finally, this study serves as a valuable resource for logistics in developing strategic plans for CFV. Furthermore, it offers insights that are beneficial for both academic researchers and industry practitioners.

5.1 Implications for academia

A wealth of studies has investigated how organizations implement CFV. However, there has yet to be research that incorporates stakeholder theory into the CFV implementation framework. This study introduces a novel and comprehensive evaluation framework designed specifically for CFV implementation.

Furthermore, it elucidates key factors affecting CFV from the perspectives of various experts, revealing differing opinions based on management levels and gender. As such, the innovative approach taken here provides a foundational reference for CFV evaluation in diverse contexts. The identification of critical factors for resource allocation is closely linked to inter-organizational collaboration. Given the varied expert opinions on CFV implementation, our empirical findings offer targeted insights for companies assessing CFV.

In summary, prior research has mainly focused on general CFV-related factors through factor analysis or regression techniques. However, practical applications of these findings—such as factor loadings and β values—highlight challenges in establishing the weights and priorities essential for managers facing resource limitations. This study addresses this gap by employing the MCDM method to evaluate how effectively decision-makers can implement CFV.

5.2 Implications for Practitioners

In the competitive logistics sector, comprehensive evaluations for CFV are increasingly vital. This research provides several key insights for practitioners. Firstly, many logistics firms in Taiwan are small to medium-sized enterprises (SMEs) with limited resources, making the widespread adoption of CFV assessments particularly impactful. Recognizing the primary factors influencing CFV offers valuable guidance for decision-makers contemplating this initiative.

Secondly, the findings reveal that regulatory and internal stakeholders are the most significant influences on CFV. Therefore, prioritizing these dimensions is crucial when assessing CFV feasibility. Additionally, implementing new technologies often requires substantial financial and resource investment, making it essential for CEOs to weigh the economic implications of CFV adoption.

Lastly, stakeholders possess diverse concerns regarding CFV implementation. Nevertheless, it is vital to consider all perspectives, as CFV is an inevitable trend that impacts management across all levels and genders within logistics firms.

5.3 Limitations and Suggestions

Despite the contributions of this study to both theory and practice, several limitations persist. First, the theoretical framework that incorporates stakeholder theory for CFV evaluation may have overlooked certain elements. Future research could explore this topic from different angles.

Second, this study relied on insights from a limited number of experts; thus, expanding the sample size in future research could enhance the reliability of the findings. Moreover, while this study focuses solely on stakeholder theory related to CFV, other theoretical frameworks could also be considered in future investigations. Finally, employing diverse methodologies, such as longitudinal studies and in-depth interviews, could help uncover additional factors influencing CFV.

References

Chen, Z., & Wu, J. (2022). Evolution of logistics industry carbon emissions in Heilongjiang Province, China. Sustainability, 14(15), 9758. https://doi.org/10.3390/su14159758

Davis, G. F., & Thompson, T. A. (1994). A social movement perspective on corporate control. *Administrative Science Quarterly*, 39(1), 141–173. https://doi.org/10.2307/2393497

El Geneidy, S., Baumeister, S., Govigli, V. M., Orfanidou, T., & Wallius, V. (2021). The carbon footprint of a knowledge organization and emission scenarios for a post-COVID-19 world. *Environmental Impact Assessment Review,* 91, 106645. https://doi.org/10.1016/j.eiar.2021.106645

Fassin, Y. (2008). Imperfections and shortcomings of the stakeholder model's graphical representation. *Journal of Business Ethics*, 80, 879–888. https://doi.org/10.1007/s10551-007-9467-9

Fan, J., Meng, X., Tian, J., Xing, C., Wang, C., & Wood, J. (2023). A review of transportation carbon emissions research using bibliometric analyses. *Journal of Traffic and Transportation Engineering* (English Edition), 10(5), 878–899. https://doi.org/10.1016/j.jtte.2023.09.002

Freeman, R. E. (1984). Strategic management: A stakeholder theory. *Journal of Management Studies*, 39(1), 1–21. https://doi.org/10.1111/j.1467-6486.1984.tb00677.x

Gallo, A. (2022, July). The logistic carbon footprint: A dynamic calculation tool for an indicator of the sustainability of logistic processes with a case study on the Port of Trieste. In *International Conference on Computational Science and Its Applications* (pp. 109–123). Springer International Publishing. https://doi.org/10.1007/978-3-031-04544-8_9

Herold, D. M. (2018). *The influence of institutional and stakeholder pressures on carbon disclosure strategies: An investigation in the global logistics industry*. Griffith University: Nathan, Australia. https://doi.org/10.25904/1912/2401

Hill, C. W., & Jones, T. M. (1992). Stakeholder-agency theory. *Journal of Management Studies*, 29(2), 131–154. https://doi.org/10.1111/j.1467-6486.1992.tb00657.x

IEA. (2022). *CO2 emissions from fuel combustion: Highlights*. IEA, Paris. https://doi.org/10.1787/18a41f25-en

Jones, T. M., Felps, W., & Bigley, G. A. (2007). Ethical theory and stakeholder-related decisions: The role of stakeholder culture. *Academy of Management Review*, 32(1), 137–155. https://doi.org/10.5465/amr.2007.23463924

Keršulienė, V., Zavadskas, E. K., & Turskis, Z. (2010). Selection of rational dispute resolution method by applying new step-wise weight assessment ratio analysis (SWARA). *Journal of Business Economics and Management*, 11(2), 243–258. https://doi.org/10.3846/jbem.2010.12

Kinicki, A., & Williams, B. K. (2003). *Management: A practical introduction*. McGraw-Hill.

Li, D., Lin, H., & Yang, Y. W. (2016). Does the stakeholders–corporate social responsibility (CSR) relationship exist in emerging countries? Evidence from China. *Social Responsibility Journal*, 12(1), 147–166. https://doi.org/10.1108/SRJ-10-2014-0135

Lopes de Sousa Jabbour, A. B., Chiappetta Jabbour, C. J., Sarkis, J., Latan, H., Roubaud, D., Godinho Filho, M., & Queiroz, M. (2021). Fostering low-carbon production and logistics systems: Framework and empirical evidence. *International Journal of Production Research*, 59(23), 7106–7125. https://doi.org/10.1080/00207543.2021.1956747

Peng, Y. H., Chen, Y. H., Huang, P. C., Wu, H. C., Wang, S. H., Cheng, K. C., & Chuang, Y. C. (2024, April). The design and evaluation of an IoT tracker for carbon footprint verification on agricultural machinery. In *2024 10th International Conference on Applied System*

Shou, Y., Wu, C., Shao, J., Hu, W., & Lai, K. H. (2023). Does green technology innovation contribute to logistics companies' market value? The effects of stakeholder engagement and public attention. *Transportation Research Part E: Logistics and Transportation Review*, 176, 103227. https://doi.org/10.1016/j.tre.2023.103227

Sun, Q. (2017). Research on the influencing factors of reverse logistics carbon footprint under sustainable development. *Environmental Science and Pollution Research*, 24, 22790–22798. https://doi.org/10.1007/s11356-017-0355-0

Thakkar, J. J., & Thakkar, J. J. (2021). Stepwise weight assessment ratio analysis (SWARA). *Multi-Criteria Decision Making*, 281–289. [DOI unavailable]

Xue, J., Xu, Y., & Yang, Y. (2023). Power enterprises-oriented carbon footprint verification system using edge computing and blockchain. *Frontiers in Energy Research*, 10, 989221. https://doi.org/10.3389/fenrg.2022.989221

How to cite this article:
Yeh C. C. "et al." (2025) 'Exploring Key Success Factors for Carbon Footprint Verification in Logistics Enterprises through Stakeholder Theory', *International Multidisciplinary Research Journal*, Volume: I; March 2025; Page 1-10. DOI: https://doi.org/10.47722/imrj.2001.35