

Sustainable Development Performance of Maritime Companies Using the AHP-TOPSIS Approach

Sacit Tekin Günaydın¹, Volkan Çetinkaya², Durmuş Ali Deveci²

Sustainable development has recently become a crucial concept, with numerous global efforts to promote it. The maritime transport sector, as a key participant in global commerce, bears significant responsibilities for sustainable development. However, this responsibility extends beyond a single dimension, such as economic sustainability. This study aims to select sustainable maritime transport performance criteria and rank them by their significance. Additionally, it seeks to determine which maritime transport company has performed better in terms of sustainable development over the years. The Analytic Hierarchy Process (AHP) is used to weight the criteria, and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is applied to evaluate the sustainable development performance of maritime transport companies over time. Three main criteria and eleven sub-criteria were identified through the literature and weighted using AHP. The sustainable development performances of three maritime transport companies were then analyzed by year. The results indicate that the economic dimension is considered the most important in evaluating sustainable development performance, while the social dimension is viewed as the least important. These findings provide a comprehensive approach to understanding and evaluating sustainable development performance in the maritime transport sector.

KEY WORDS

- ~ Sustainable development
- ~ Maritime transport
- ~ Sustainability performance evaluation
- ~ Sustainable maritime transportation criteria
- ~ Analytic hierarchy process (AHP)
- ~ Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

¹ Schenker Arkas Shipping and Trade Inc., İzmir, Türkiye

² Dokuz Eylül University, Maritime Faculty, İzmir, Türkiye

e-mail: volkan.cetinkaya@deu.edu.tr

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1. INTRODUCTION

Maritime transport remains central to global trade and the manufacturing supply chain, accounting for more than 80 percent of world merchandise trade by volume (UNCTAD, 2019) and over 70 percent by value (UNCTAD, 2017). Maritime transport and globalized trade are essential for promoting sustainable economic growth and distributing wealth worldwide. Additionally, maritime transport, which connects producers and customers, is a critical part of the intermodal transport system (Grațîela, 2019). However, the sector is expected to be more economically efficient, environmentally sustainable, and socially inclusive (UNCTAD, 2018). Maritime transport is widely regarded as a cost-efficient and environmentally friendly mode of transportation.

In 2015, the United Nations published *Transforming Our World: The 2030 Agenda for Sustainable Development* (UN, 2015) and adopted 17 sustainable development goals. These goals, which include transport and infrastructure issues, highlight the importance of transport. Transport is considered a key component, directly or indirectly, in achieving eight goals and 11 targets, although none of the goals is specifically dedicated to transport or maritime transport (UNCTAD, 2016). To establish a sustainable maritime transport system, all relevant institutions and stakeholders must meet the requirements of sustainable development, as the United Nations 2030 Agenda is closely linked to sustainability. The International Maritime Organization (IMO) is responsible for identifying the requirements necessary to promote sustainable maritime transport (Sciberras & Silva, 2019).

While research has examined various aspects of maritime sustainability, most studies have focused on port authorities or supply chain frameworks, with little attention to comparing sustainability performance at the company level. Furthermore, few studies have used a systematic, multi-criteria decision-making methodology that integrates economic, environmental, and social dimensions of sustainability. This research addresses this gap by applying a hybrid AHP–TOPSIS model to company-level sustainability reports from the container shipping sector, evaluating sustainability performance over time.

1.1. Research Motives

The ultimate goal of sustainable development is to maintain a balance among the economic, social, and environmental dimensions that constitute sustainable development (Mensah & Casadevall, 2019). The triple bottom line approach, which advances sustainable development goals, is a key tool for addressing the balance between growth and sustainability. However, not all communities fully understand the triple bottom line, including the maritime transport industry (Cabezas-Basurko et al., 2008). As a result, the maritime transport industry has faced challenges in adopting a balanced approach to the economic, environmental, and social dimensions (Kitada & Langåker, 2018). Over the past decade, there has been a significant increase in attention to environmental concerns. Yet, only a few studies have specifically addressed approaches that encompass all dimensions of sustainable development. It is important to develop an approach for the maritime transport industry that considers the economic and social aspects of sustainable development alongside the environmental dimension. Until recently, it was difficult to assess the sustainable development performance of maritime transport companies, as most did not publish comprehensive and separate sustainability reports. Recently, several leading maritime transport companies have started releasing sustainability reports to meet stakeholder demands and expectations. However, achieving sustainable maritime transport requires an effective and comprehensive methodology to evaluate companies' economic, environmental, and social performance within the context of sustainable development.

1.2. Research Objectives

This study makes a valuable contribution to the field of sustainable development by examining and answering the following research questions:

RQ1: What are the primary factors that must be considered when evaluating the performance of marine transportation in relation to sustainable development?

RQ2: How well do the maritime transport companies conduct their businesses in accordance with the sustainable development performance evaluation criteria?

To answer the problems raised above, the following research objectives have been developed:

RO1: To determine the performance criteria in terms of sustainable maritime transport

RO2: To weight the significance levels of the criteria by using the analytic hierarchy process

RO3: To find out which maritime transport company is more successful in terms of sustainable development performance by years.

This research employed an integrated AHP-TOPSIS approach. AHP was used to calculate the weights of sustainable development criteria, while TOPSIS was used to evaluate the sustainable development performance of three selected maritime transport companies.

The remainder of the study is organized as follows: The second chapter presents a literature review of sustainable development and sustainable maritime transport concepts. The third chapter describes the research methodology. The fourth chapter explains the research framework, and the fifth chapter presents a case study. Finally, the conclusion summarizes the study and discusses its contributions, limitations, and recommendations.

2. LITERATURE REVIEW

Uncontrolled economic growth has affected both the environment and the social system. It faces major challenges, including climate change, interpersonal conflicts, and wealth inequality. The equilibrium of ecosystems should be maintained at all costs, as it is widely accepted that the development of civilization and individuals depends on nature and cannot exist without it (Hull, 2008). As a result, different generations continually ask how long the earth can support our way of life and economic systems. We may be able to address this important question using the sustainable development paradigm.

Fundamentally, the sustainable development approach addresses the environment, economy, and society together (Perdan, 2010). Gillis and Vincent (2000) argue that while economic growth is essential, it is not sufficient because decision-makers do not properly internalize the cost of environmental degradation when making market decisions.

Although there are numerous definitions and interpretations of sustainable development, certain common themes exist in all of them. In the influential report *Our Common Future* (WCED, 1987), also known as the Brundtland Report, sustainable development is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Sustainable development encourages people to think differently, aiming to improve welfare while addressing the limitations of the global context (Vanegas et al., 1996). These limitations refer to the constraints on environmental resources and the biosphere imposed by current technology and social organization (WCED, 1987).

Sustainable development seeks to maximize humanity’s adaptability, security, and well-being by ensuring continuous improvement without environmental degradation (Barrow, 2018). It is not a static concept aimed at establishing fixed structures or determining permanent features of economic, political, or social life. Instead, it is a continuous process whose characteristics change over time. The main goal of sustainable development is to maintain a balance among the economic, social, and environmental dimensions.

2.1. Dimensions of Sustainable Development

The dimensions of sustainable development are also known as the “triple bottom line,” which is used to evaluate projects or programs. To achieve successful outcomes, all dimensions must be considered equally. The common pattern of sustainable development is represented by overlapping circles of the economic, environmental, and social dimensions. These circles illustrate how the different dimensions of sustainable development interact and remain in balance. In addition to maintaining equilibrium among these dimensions, which are fundamental components of human existence, there is also a need to balance the interests of current and future generations (Hull, 2008). The holistic approach to sustainable development requires proper management of trade-offs, collaboration, and discrepancies among these dimensions, as well as realizing the potential of all dimensions simultaneously.

Reviewing the aftermath of past economic crises, it is clear that sustaining economic growth is crucial for any society. For a decade, promoting economic expansion was the primary focus of international policies. Maintaining the balance between economic growth and sustainable development is therefore quite difficult. However, the economic dimension is not limited to inflation, gross national product, or profit; it has a broader meaning. It is critical to the concept of sustainable development because it is a social science that explains consumption, production, and distribution (Vanegas, Dubose, & Pearce, 1996). Environmental issues have always been a concern for humanity. Especially after the Industrial Revolution, the unbalanced and enormous world economy has jeopardized the earth and caused significant harm affecting the survival and welfare of humanity and other species (Sachs, 2015). The environmental development approach aims to

build an ecological society compatible with nature. This involves harmonizing environmental conservation, social development, and economic activity.

The social dimension of sustainable development addresses how individuals and societies live together and pursue their development plans while considering the earth's limitations (Colantonio, 2009). A socially sustainable development model should meet requirements in education, health, gender equity, and welfare equity (Harris, 2000: 6). The connections between the dimensions of sustainable development remain somewhat unclear, as the concept of social sustainable development has not been adequately theorized. Additionally, there have been few attempts to define the social dimension of sustainable development as a separate dimension in the past (Colantonio, 2009). However, in recent years, there have been more efforts to promote understanding of the social dimension. Holistic and more comprehensive approaches have emerged in the theoretical and applied social science literature, as well as in policy development (Dalal-Clayton & Sadler, 2014).

2.2. Sustainable Maritime Transport

The intercontinental transportation of manufactured products is essential for development and growth. However, this cannot be achieved without maritime transportation. Maritime transport supports international trade, economic growth, and improved standards of living (ICS, 2013). Energy-efficient, low-carbon, safe, and rule-based maritime transport systems foster environmentally conscious, socially equitable, and economically efficient development (Benamara et al., 2019).

In recent decades, there has been no consensus on a single definition of sustainable maritime transport. Cabezas-Basurko, Mesbahi, and Moloney (2008) defined sustainable maritime transport as “a cost-effective commercial activity in which the environmental load does not exceed what the environment can currently and in the future bear, and that the social community (directly and indirectly) in contact with it is not negatively affected.”

It is clear that all international organizations, governments, and other stakeholders in the maritime transport industry should participate in achieving sustainable maritime development and cooperate to address all three dimensions of sustainable development (ICS, 2013). Maritime transport is regulated by international conventions because of its global nature. The IMO has made several efforts to address maritime transportation issues, including adopting regulations that establish minimum criteria for the safety of services provided by marine transport businesses. For this reason, the IMO plays a vital role in promoting the sustainable development goals and the 2030 agenda, assisting member states through technical cooperation and policy advice.

To achieve sustainable development, maritime transport companies must address challenges that threaten their long-term viability and sustainable growth. The concept of sustainable maritime transport must be adopted not only at the societal level but also at the organizational level, as unsustainable maritime transport activities may result in poor service and hinder the achievement of sustainable development goals (Bhaskar, Cahoon, & Chen, 2014). In practice, companies review performance indicators to assess the effects of their activities on sustainable maritime transport. These indicators demonstrate the economic, environmental, and social impacts of sustainable maritime transport activities, and the assessment outcomes are shared with stakeholders (Grațîela, 2019).

2.3. Dimensions of Sustainable Maritime Transport

Achieving sustainability in maritime transport processes can be challenging, as it requires equitable operations throughout each stage. It is essential to balance the diverse and often competing economic, environmental, and social objectives to support the sustainable development of maritime transport.

The primary goal of the economic dimension is to optimize economic efficiency. In contrast, the environmental dimension focuses on understanding the impacts of maritime activities on the environment. The social dimension aims to address societal needs and propose practical solutions to challenges arising from maritime transportation. The economic, environmental, and social aspects of sustainability in maritime transport display distinct characteristics depending on factors such as vessel size, emissions, and geographical scope.

At the corporate level, Ji et al. (2019) emphasized that maritime transport companies should conduct their activities with consideration for both the environment and society. Therefore, organizations must account for the benefits to external stakeholders when pursuing profitability.

The economic dimension of sustainable development seeks to promote economic growth while also considering negative impacts on environmental and social aspects. This approach enables industry participants to adopt more cost-efficient and environmentally friendly processes (Cabezas-Basurko et al., 2008). Thus, the global maritime transport industry

should strive to improve environmental and social outcomes in pursuit of sustainable development, while also addressing economic concerns, as these are integral to the process (ICS, 2013).

Unsustainable maritime transport activities are a major source of GHG emissions, pollution, and resource depletion, even though maritime transport is often considered more environmentally friendly in terms of ton-miles. Greenhouse gas (GHG) emissions, such as carbon dioxide (CO₂), have serious effects on the climate, environment, and public health. Other significant emissions, including sulfur oxides (SO_x) and nitrogen oxides (NO_x), contribute to the formation of particulates and the acidification of marine and terrestrial environments.

The social dimension of the triple bottom line approach encompasses a wide range of organizational performance criteria. In recent years, companies' social performance has been evaluated by measuring employee wellbeing, particularly regarding safety and health. However, the social dimension has received less attention compared to the other dimensions of sustainable development in the maritime industry (Lam, 2015).

In the maritime transport industry, the concept of sustainable development is crucial for reducing maritime accidents and mitigating external risks (Dragan, 2012). For this reason, the IMO has adopted the Safety of Life at Sea (SOLAS) convention to address safety issues in maritime transport. Sustainable maritime transport must foster a safety culture by raising standards and implementing best practices worldwide. This safety culture should not only comply with regulations but also enhance safety through proactive measures (IMO, 2013).

The maritime transport industry has historically been dominated by male workers. However, companies that promote the employment of women can help change this dynamic, foster a more diverse and qualified workforce, and advance related sustainable development goals (UNCTAD, 2017). Although there have been various efforts and progress toward gender equality, the workforce participation rate for women remains inadequate. Advancing gender equality in the workforce can also contribute to economic development and growth (UNCTAD, 2019).

2.3.1. Literature Review on Sustainability Performance in the Maritime Sector

The following sub-sections present literature reviews on sustainable development, sustainable maritime transport, and existing research gaps in sustainable maritime development. A comprehensive literature search was conducted in the Scopus and Web of Science databases using search terms such as "sustainable development," "maritime sustainability," "maritime sustainability performance evaluation," "AHP," and "TOPSIS." Based on relevance and methodology, 40 papers out of 74 reviewed over the past thirteen years were included.

Global decarbonization objectives, stakeholder and public pressure, and increasing environmental regulations have made sustainability a major focus in the maritime industry. In recent years, researchers have examined various factors, including environmental impact, operational efficiency, regulatory compliance, digitalization, stakeholder engagement, and the integration of sustainability into business strategy. We classified the existing literature according to research aims, variables used, and methodological approaches. Maritime sustainability literature has been analyzed from several perspectives, including security, regulatory frameworks, and digitalization for sustainable performance assessment.

Nassar and Salama (2018) provided key insights into integrated sustainable logistics systems, highlighting port efficiency, resource utilization, and environmental impact through conceptual analysis. Their research laid the groundwork for understanding how systemic logistics operations align with sustainability objectives. Lee et al. (2019) highlighted the increasing focus on sustainability challenges in maritime transport, noting the development of sectoral awareness, legislative changes, and managerial issues related to environmental and social performance. Using exploratory factor analysis to develop a comprehensive model for maritime logistics performance, Sheikh et al. (2023) made a significant contribution to performance assessment frameworks. They grouped 19 key indicators into four categories: port operations, hinterland connection, supply chain integration, and sustainability.

Edgerton (2021) examined security and regulatory issues, emphasizing the link between maritime security and sustainable development. He argued that sustainability cannot be achieved without a robust safety framework, especially in geopolitically sensitive regions. Asgari et al. (2015) used the Analytic Hierarchy Process (AHP) to develop a sustainability rating for major UK ports, incorporating both economic and environmental metrics. Their approach demonstrated how structured decision-making tools can help assess port performance within a multidimensional framework. Jahn et al. (2018) explored the role of Industry 4.0 technologies, including blockchain, big data analytics, and the Internet of Things, in maritime sustainability. Their study showed that digital transformation enhances operational resilience, reduces carbon emissions, and improves traceability.

Another body of research focuses on the operational and strategic aspects of sustainability in maritime logistics, emphasizing supply chain integration, stakeholder engagement, and infrastructure development. Langer and Acciaro (2025) investigated supply chain sustainability and stakeholder engagement. Their study and case-based findings indicate that companies incorporating sustainability into procurement processes not only comply with environmental regulations but also gain a competitive advantage. Bernacki and Lis (2021) examined the long-term benefits of green port infrastructure investments, finding that these initiatives reduce externalities and deliver financial returns through efficiency gains. Similarly, Lähdeaho et al. (2020) found that maritime companies actively reorganizing logistics operations and investing in clean technology can achieve sustainability goals. The literature demonstrates significant methodological diversity. Conceptual and literature-based studies established foundational frameworks and theoretical insights, while qualitative methods such as interviews, case studies, and surveys provided detailed understanding of company-level applications. Quantitative methods, including exploratory factor analysis, analytic hierarchy process (AHP), and panel data regression, were used to model performance indicators, rank ports, and assess operational productivity. However, there is a clear lack of research utilizing real-time, longitudinal data from maritime shipping companies' sustainability reports.

Although previous literature has significantly advanced our understanding of sustainable performance in maritime logistics, several important gaps remain. The sustainability practices of maritime transport companies have not received sufficient attention, as most studies have focused on port authorities or aggregated national-level logistics networks. Additionally, there is a lack of integration between economic and environmental performance measurements within a single framework. Little attention has also been given to how internal factors, such as stakeholder involvement and staff-related sustainability criteria, influence sustainable performance. Given these shortcomings, this study aims to use survey-based data from industry professionals to empirically analyze the criteria that influence sustainability performance in maritime companies and to measure the sustainability performance of selected maritime companies, with an emphasis on financial, environmental, and social factors.

While previous studies have primarily focused on port sustainability performance, there is a lack of research on company-level sustainability performance assessment in the maritime industry. This study seeks to advance an AHP-TOPSIS-based model at the company level, enabling a more detailed evaluation of sustainability options. Unlike infrastructure-focused assessments, company-level evaluation provides significant insights into the extent to which companies prioritize economic, environmental, and social dimensions. This perspective bridges the gap between macro-level sustainability frameworks and micro-level management practices, offering practical guidance for both maritime shipping companies and policymakers in the maritime industry.

3. METHODOLOGY

This study employed an integrated AHP-TOPSIS model due to its effectiveness in assessing multiple, often competing, sustainability criteria. The AHP was used to determine the relative importance of each sustainability factor based on expert opinions, while the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) provided a clear ranking of options by evaluating their relative closeness to the optimal solution. This combination is especially suitable for our study environment, as it enables the integration of qualitative expert judgment and quantitative evaluation within a transparent framework. Considering the multidimensional aspects of maritime sustainability, which involve trade-offs among environmental, economic, and social objectives, the AHP-TOPSIS hybrid model offers a balanced, systematic, and comprehensible decision-support tool.

The AHP-TOPSIS hybrid approach provides a systematic and clear framework for sustainability assessment, though each methodology has its own advantages and disadvantages. The Analytic Hierarchy Process (AHP) is especially effective at capturing expert judgment and ensuring consistency in criteria weighting through pairwise comparisons. However, it may introduce inconsistencies as the number of criteria increases.

TOPSIS offers a straightforward mechanism for ranking alternatives based on their proximity to an ideal solution. It fully utilizes attribute information, provides a cardinal ranking of alternatives, and does not require attribute preferences to be independent (Behzadian et al., 2012). However, considering the closeness of an option to both the "positive ideal solution" and "negative ideal solution" may not always reflect reality when evaluation indicators conflict (Liu & Yang, 2023).

The integration of AHP allows decision-makers to transparently and consistently record subjective preferences. By aligning qualitative assessments with numerical rankings, AHP and TOPSIS complement each other to provide a methodical approach. TOPSIS then delivers a clear and understandable assessment of company performance based on these weighted metrics. Together, these methodologies enable a systematic evaluation consistent with the study's aim of developing a structured, multi-criteria model that addresses the complexities of maritime sustainability. The research methodology used in this study is described in detail in the following subsections.

3.1. Analytic Hierarchy Process

AHP is a widely used Multi-Criteria Decision-Making (MCDM) technique for solving complex group decision-making problems (Lahane and Kant, 2021). It hierarchically evaluates and organizes decision criteria. MCDM methods primarily aim to ensure consistency and compatibility between the objectives of decision-makers and the decision-making process. To establish the weights of criteria, the AHP technique offers several advantages over other MCDM methods such as ANP, PROMETHEE, ELECTRE, MAUT, UTADIS, and others. According to Khandelwal and Barua (2020), AHP has the following advantages: (1) The Analytic Hierarchy Process (AHP) is effective in handling both qualitative and quantitative data. (2) The use of a hierarchical structure effectively addresses the diverse challenges encountered in decision-making situations. (3) Evaluating the consistency of an MCDM situation is beneficial for decision-makers. As an essential approach in decision making, AHP is designed to address both rational and perceptual factors to select the best option from various alternatives assessed against specific criteria (Saaty & Vargas, 2012).

Over the years, interest in the use of AHP has increased significantly, and it has been regularly applied to address issues in the maritime industry. The analytic hierarchy approach is a powerful tool for simplifying complex decision problems and reducing decision-makers' liability. These characteristics of the analytic hierarchy process are highly applicable to a wide range of activities, and it has been used in many decision-making areas such as prediction, alternative selection, business process re-engineering, quality management, benchmarking, healthcare, public policy decisions, and resource allocation (Bhushan & Rai, 2004). Therefore, this research employs the AHP method to assess sustainable maritime transport criteria and evaluate maritime companies in terms of sustainable transport.

The steps of the AHP method are as follows:

Step 1: Create the hierarchy of criteria and alternatives

The foundation of the analytic hierarchy process is the hierarchical structure, which includes an objective, criteria, sub-criteria, and alternatives. It is essential to create a hierarchy of precise criteria and alternatives to implement the AHP technique (Qu et al., 2018), as illustrated in Figure 1.

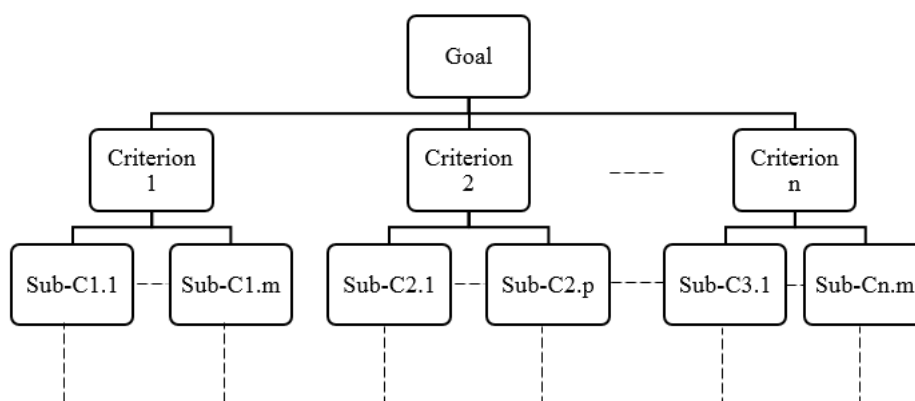


Figure 1. The hierarchical structure of AHP (Source: Tzeng and Huang, 2011).

The objective for the decision problem is established in the first level of the hierarchy structure. The objective is broken down into criteria at the following level, and then the criteria in the second level might be subdivided into sub-criteria in the lower levels.

Step 2: Develop a pair-wise comparison decision matrix

For all criteria, a pair-wise comparison decision matrix is created, where a_{ij} ($i=1,2,3...n$ and $j=1,2,3...n$) in the matrix stands for a quantified judgment on a pair of criteria as seen in Figure 2.

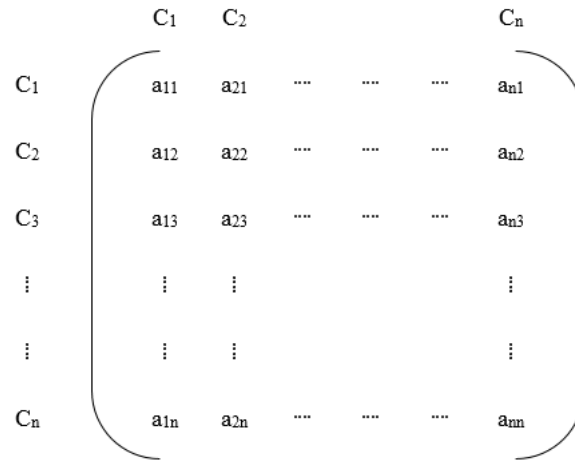


Figure 2. Comparison matrix of AHP (Source: Qu et al., 2018:9).

The fundamental scale table (Table 1) enables to show which factor is how many times superior over another one to be able to compare the factors (Saaty, 2008).

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak	
3	Moderate importance	Experience and judgement slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favor one activity over another
6	Strong plus	
7	Very strong importance	An activity is favored very strongly over another
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation

Table 1. Tables should have descriptive names and be numbered in sequence with Arabic numerals (Source: Saaty and Vargas, 2012).

Step 3: Normalize decision matrix and priorities

To accomplish this computation, each set of column values is added together, and then each value must be divided by a corresponding total value. The average of the values of the “k”th row is calculated to acquire the relative weight of the “k”th criteria (Qu et al., 2018: 9).

$$W_k = \frac{1}{n} \sum_{j=1}^n \frac{a_{kj}}{\sum_{i=1}^n a_{ij}} \quad (k=1, 2, 3, \dots, n) \dots \dots \dots (1)$$

Step 4: calculate the consistency ratio

A consistency test has to be done since a certain level of consistency is necessary to obtain significant weights. Consistency Ratio (CR) enables to monitor the consistency of the comparison matrices.

$$CR = \frac{CI}{RI} \dots \dots \dots (2)$$

CI is the consistency index, and RI is the random index. Table 2 shows RI values corresponding to the number of criteria used in research.

$$CI = \frac{\Lambda_{max} - n}{n - 1} \dots \dots \dots (3)$$

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.11	1.35	1.40	1.45	1.49

Table 2. Random consistency index (Source: Saaty and Vargas, 2012).

The maximum eigenvalue (λ_{max}) is calculated as shown in the following equation.

$$\Lambda_{max} = \frac{\sum_{j=1}^n \frac{\sum_{k=1}^n w_k a_{kj}}{w_j}}{n} \quad (j=1, 2, 3, \dots, n), (k=1, 2, 3, \dots, n) \dots \dots \dots (4)$$

' w_j ' and ' w_k ' are the weights of criteria obtained in Step 2.

3.2. The Technique for Order of Preference by Similarity to an Ideal Solution (TOPSIS)

The TOPSIS methodology is based on selecting distances from both positive and negative ideal solutions. The ranking of alternatives is obtained by measuring the Euclidean distances (San Cristóbal Mateo, 2012). For example, if the criteria weights are identical and both criteria are to be maximized, Alternative A is preferred according to TOPSIS because it is closer to the ideal solution and farther from the anti-ideal solution (Ishizaka & Nemery, 2013).

The TOPSIS method is used for selection and evaluation problems and has been applied in various important domains such as manufacturing, finance, banking, and information technology to evaluate processes, suppliers, and locations (Jigeesh et al., 2018). In some cases, TOPSIS can also serve as a substitute for AHP when ranking alternatives. Specifically, AHP is used to determine the weights of the criteria, while TOPSIS is used to rank the alternatives by priority (Qu et al., 2018). Thus, the TOPSIS method has been effectively used for problem-solving due to its intuitive nature and ease of implementation.

A sample matrix is shown in Figure 3, where, A1, A2, . . . , Am are alternatives C1, C2, . . . , Cn are attributes, and ' x_{ij} ' represents the original attribute values.

	C1	C2				Cn
A1	X11	X12	...	...	...	X1n
A2	X21	X22	...	...	...	X2n
⋮	⋮	⋮	⋮
⋮	⋮	⋮				⋮
⋮	⋮	⋮				⋮
Am	Xm1	Xm2	...	...	...	Xmn

Figure 3. Decision matrix of TOPSIS (Source: Yang, 2020).

The steps of TOPSIS method are given below:

Step 1: Develop normalized decision matrix (Y).

$$Y = (y_{ij})_{m \times n} \quad (i=1, 2, 3, \dots, m), (j=1, 2, 3, \dots, n) \dots \dots \dots (5)$$

$$y_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (i=1, 2, 3, \dots, m), (j=1, 2, 3, \dots, n) \dots \dots \dots (6)$$

Step 2: Develop the weighted normalized decision-making matrix R

$$R = (r_{ij})_{m \times n} \quad (i=1, 2, 3, \dots, m), (j=1, 2, 3, \dots, n) \dots \dots \dots (7)$$

$$r_{ij} = w_j y_{ij} \quad (i=1, 2, 3, \dots, m), (j=1, 2, 3, \dots, n) \dots \dots \dots (8)$$

Step 3: Calculate both the positive(r_j^+) and the negative(r_j^-) ideal solutions are determined.

If the aim is maximization;

$$\begin{cases} r_j^+ = \max r_{ij} (i=1, 2, 3, \dots, m), (j=1, 2, 3, \dots, n) \dots \dots \dots (9) \\ r_j^- = \min r_{ij} \end{cases}$$

If the aim is minimization;

$$\begin{cases} r_j^+ = \min r_{ij} (i=1, 2, 3, \dots, m), (j=1, 2, 3, \dots, n) \dots \dots \dots (10) \\ r_j^- = \max r_{ij} \end{cases}$$

Step 4: Calculate the Euclidean distances of each alternative for both positive and negative ideal solutions.

$$S_i^+ = \sqrt{\sum_{j=1}^n r_{ij} - r_j^+)^2} \quad (i = 1, 2, 3, \dots, m), (j = 1, 2, 3, \dots, n) \dots \dots \dots (11)$$

$$S_i^- = \sqrt{\sum_{j=1}^n r_{ij} - r_j^-)^2} \quad (i = 1, 2, 3, \dots, m), (j = 1, 2, 3, \dots, n) \dots \dots \dots (12)$$

Step 5: Calculate the result of the evaluation (S_i) for each alternative.

$$S_i = \frac{S_i^-}{S_i^+ + S_i^-} \dots \dots \dots (13)$$

Step 6: Rank the alternatives.

The alternatives are ranked based on their evaluation results.

4. PROPOSED RESEARCH FRAMEWORK

The current study evaluates the sustainable development performance of maritime companies using an integrated AHP-TOPSIS approach. The research design of the proposed framework is shown in Figure 4. In this model, AHP is used to determine the relative weights of sustainability criteria through pairwise comparisons. These weights are then applied in the TOPSIS model. This sequential process links qualitative judgment with quantitative ranking to establish a coherent decision-making process. The hybrid approach provides consistency and transparency by combining subjective judgments with objective analysis.

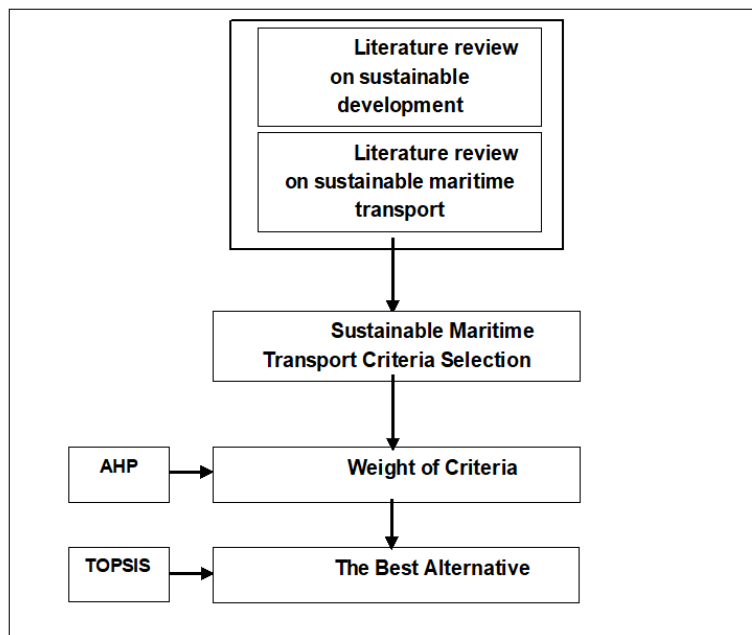


Figure 4. Research Framework

5. EMPIRICAL CASE EXAMPLE

This section is divided into four subsections: problem definition, the selection procedure for sustainable maritime criteria determining criteria weights via AHP, performance evaluation by TOPSIS and interpretation of findings.

5.1. Problem Definition

The maritime transport sector, comprising many stakeholders, is international in all respects and is critical for the global economy and sustainable development (Dragan, 2012). All areas concerning maritime transport must be properly reorganized, as maritime transport is at the core of the global economy. Furthermore, all activities related to adapting sustainable development to maritime transport processes must consider the economic, environmental, and social dimensions of sustainable development (Comtois & Slack, 2007). The main issue regarding the maritime transport industry's negative reputation is related to the structure of the industry. It is clear that efforts are needed to enhance quality standards and safety in maritime transport processes and to reduce negative external factors (Birwatkar, 2017). Unsustainable maritime transport practices must be identified, and relevant sustainable criteria should be integrated into maritime transport policies and planning to make the process more efficient. It is evident that all international organizations, governments, and other stakeholders in the maritime transport industry should be involved in achieving sustainable maritime development and should cooperate to achieve all three dimensions of sustainable development.

This case covers the performance evaluation of maritime transport companies in the container transport sector in terms of sustainable development criteria determined through a literature review. The study sample includes three maritime transport companies that publish annual sustainability reports with tangible data. In this process, sustainability and annual reports published between 2017 and 2019 were included. Due to confidentiality, organization names are not disclosed and are referred to as MC1, MC2, and MC3 maritime transport companies.

To weight the related criteria using the AHP technique, experts must be selected according to the aim of the decision-making problem, and they should be chosen from the maritime transport sector or relevant academic institutions. In this context, 12 experts were selected from academia and the maritime transport sector to weigh the criteria and sub-criteria. These experts were chosen based on their specialization and experience in the field. The experts are either scholars with relevant academic studies or practitioners in managerial positions in the field. The expert group consists of four university professors with expertise in sustainability, two senior port operation executives from different maritime shipping companies, one sustainability department manager with two sustainability experts from a maritime company, and three logistics managers from freight-forwarding companies. On average, the 12 experts had 18 years of professional experience in the maritime and freight transportation sector.

In the final part, the TOPSIS method was used to determine which alternative is more successful in terms of sustainable development criteria.

5.2. The selection procedure for sustainable maritime transportation criteria

To carry out the AHP method, three main sustainable development criteria and eleven sub-criteria were chosen after reviewing relevant literature and reports published by maritime transport companies. From the literature, eleven criteria are listed in Table 3. The economic, environmental, and social dimensions are chosen as the main criteria. Return on sales (ROS), return on equity (ROE), return on assets (ROA), fuel oil consumption rate, carbon dioxide emission rate, sulfur oxides emission rate, nitrogen oxides emission rate, rate of female employees in the company, rate of female members at the management level, number of work-related fatalities, and rate of injuries (lost time injuries) are chosen as sub-criteria corresponding to the main criteria.

EC (Economic criteria code)	Economic dimension	GRI (Global reporting initiative)	SDG (Sustainable development goal)	References
EC 1	ROS	GRI 201: Economic Performance	2, 5, 7, 8, 9	(Chiang and Hwang, 2007) (Lee, et al., 2018), GRI (2016), GRI (2017)
EC 2	ROE	GRI 201: Economic Performance	2, 5, 7, 8, 9	(Chiang & Hwang, 2007) (Lee, et al., 2018), GRI (2016), GRI (2017)
EC 3	ROA	GRI 201: Economic Performance	2, 5, 7, 8, 9	Chiang & Hwang, 2007) (Lee et al., 2018), GRI (2016), GRI (2017)
EN (Environmental criteria code)	Environmental dimension	GRI (Global reporting initiative)	SDG (Sustainable development goal)	References
EN 1	Fuel oil consumption	GRI 302: Energy	7,8,12,13	(Lirn et al., Shang, 2014) (Cabezas-Basurko et al., 2008) (Lirn et al., 2014), GRI (2016), GRI (2017)
EN 2	CO ₂ emissions	GRI 305: Emissions	3,12,13,14,15	(Cabezas-Basurko et al., 2008), GRI (2016), GRI (2017)
EN 3	SO _x emissions	GRI 305: Emissions	3,12,13,14,15	Lirn et al., 2014) (Cabezas-Basurko et al., 2008), GRI (2016), GRI (2017)
EN 4	NO _x emissions	GRI 305: Emissions	3,12,13,14,15	(Lirn et al., 2014) (Cabezas-Basurko et al., 2008), GRI (2016), GRI (2017)
SC (Social criteria code)	Social dimension	GRI (Global reporting initiative)	SDG (Sustainable development goal)	References
SC 1	Female employee rate	GRI 405: Diversity and equal opportunity	5, 8, 10	Grant and Grant, 2015), GRI (2016), GRI (2017)
SC 2	Women in leadership	GRI 405: Diversity and equal opportunity	5, 8, 10	(Lirn et al., 2014) (Pastra, et al., 2015), GRI (2016), GRI (2017)
SC 3	Fatalities	GRI 403: Occupational Health and Safety	3, 8	(Lam, 2015), GRI (2016), GRI (2017)
SC 4	Injuries	GRI 403: Occupational Health and Safety	3, 8	(Lam, 2015), GRI (2016), GRI (2017)

Table 3. Sustainable Development Criteria from Literature

5.3. Determining criteria weights by AHP

In this stage, the dimensions of sustainable maritime transport and the criteria for each dimension are weighted using an Analytic Hierarchy Process (AHP) questionnaire. The decision matrix for all criteria was created using the geometric mean values from pairwise comparisons conducted by 12 experts. Microsoft Excel was used for the AHP calculations in this section.

The calculated consistency ratios (CR) in AHP met the accepted threshold of 0.10, indicating that expert judgments were logically coherent. These consistency results, along with the use of actual firm-level data in the TOPSIS stage, confirm the methodological validity and real-world applicability of the proposed model. Additionally, the use of actual observed data and expert-driven criteria ensures the consistency and reliability of the model.

5.3.1. Sustainable Maritime Transportation Dimension Weights

The decision matrix was created for all dimensions of sustainable maritime transportation. As a result of the calculations, sustainable maritime transportation dimension weights are obtained as shown in Table 4. The consistency ratio is computed as 0.010979375 and acceptable because lower than 10%.

Criterion	Weight
Economic Dimension (EC)	0.48797569
Environmental Dimension (EN)	0.34387833
Social Dimension (SC)	0.16814599

Table 4. Sustainable Maritime Transportation Weights

According to the findings in Table 4 the social dimension has been given the lowest importance as 0.168 while the economic has been given the highest as 0.488. This distribution implies that participants place stronger importance on economic outcomes than on social considerations. Lowest priority of social dimension can be due to industry's prioritizing of regulatory compliance and cost effectiveness over diversity and employee rates. This imbalance points out a structural challenge because ignoring social aspect can damage long-term sustainability by decreasing work motivation, company reputation and stakeholder trust.

5.3.2. Economic Dimension Criteria Weights

All calculations were made step-by-step for the economic dimension, just as they were for the sustainable development dimension weight calculations. First, a decision matrix was created for all economic dimensions of sustainable maritime transportation criteria. The weights of the economic dimension of sustainable maritime transportation criteria are given in Table 5. The consistency ratio is computed as 0.01030909 and acceptable because lower than 10%.

Criterion	Weight
ROS (EC1)	0.31267894
ROE (EC2)	0.34563943
ROA (EC3)	0.34168164

Table 5. Economic Dimension Criteria Weights

As shown in Table 5, Return on Equity (ROE), Return on Assets (ROA), and Return on Sales (ROS) were given approximately equal weights while ROE was a little higher prioritized (0.346). The close distribution shows us that no economic indicator can dominate in the evaluation process implying a balanced approach regarding financial performance assessment. This balance executes that companies consider efficiency in asset utilization, profitability in operations and equity returns rather than considering only a single dimension of financial strength. Economic dimension weighting results point out that economic sustainability cannot be assessed by unique criterion, on the contrary, a holistic approach should be adopted.

5.3.3. Environmental Dimension Criteria Weights

First, the decision matrix was created for all environmental dimensions of sustainable maritime transportation. The weights of the environmental dimension of sustainable maritime transportation criteria are given in Table 6. The consistency ratio is computed as 0.02080346 and acceptable because lower than 10%.

Criterion	Weight
Fuel Oil Consumption Rate (EN1)	0.17584438
CO ₂ Emission Rate (EN2)	0.38757069
SO _x Emission Rate (EN3)	0.26418213
NO _x Emission Rate (EN4)	0.1724028

Table 6. Environmental Dimension Criteria Weights

Table 6 identifies "CO₂ emissions rate" (0.388) is the most important criterion followed by "SO_x emission rate" (0.264) confirming regulatory and public pressure on the maritime industry to reduce greenhouse gas emissions in accordance IMO 2050 Policy. This prioritization shows that the increasing trend on climate change policies is a driving force regarding sustainability in maritime industry. Results infer that maritime companies are expected to allocate more resources to decarbonization technologies, cleaner fuels and compliance with international emission reduction targets. On the other hand, high score of CO₂ emission rate factor shows its role in global warming, while the focus on SO_x Emission Rate should not be ignored in achieving maritime environmental sustainability. Consequently, results emphasize that maritime sustainability roadmap is shaped simultaneously by regulations and public expectations.

5.3.4. Social Dimension Criteria Weights

Like the weight estimates for the sustainable maritime transportation dimensions, the social dimension calculations were done step by step. Initially, a decision matrix was constructed considering every social criteria of the sustainable marine

transportation requirements. Table 7 lists the social factor weights for the sustainable marine transportation. The consistency ratio is computed as 0.000669119 and acceptable because lower than 10%.

Criterion	Weight
Female Employee Rate (SC1)	0.0723506
Women in Leadership Rate (SC2)	0.07697805
Fatalities (SC3)	0.48911722
Lost Time Injury Rate (SC4)	0.36155412

Table 7. Social Dimension Criteria Weights

Table 7 explains that “fatalities” were given the highest weight (0.489), followed by “lost time injury rate” (0.362). On the other hand, gender related criteria were given significantly lower weight (approximately 0.07 each). The allocation shows us maritime experts consider health and safety as the core social sustainability. The low score of gender-related indicators points out that diversity and inclusion continue to receive little attention. Such neglect of societal issues can disrupt the efforts to achieve a comprehensive and balanced approach to social sustainability in maritime industry.

5.4. Performance Evaluation by TOPSIS

TOPSIS was used to assess the sustainability performance of selected maritime companies, designated as MC1, MC2, and MC3. MC1 is a leading global container shipping operator with a vessel capacity of 4.5 million TEU. The company operates internationally, providing integrated logistics and terminal services alongside maritime transportation. It employs over 100,000 people worldwide and has a substantial capital structure as a publicly traded company. It is recognized for its proactive decarbonization initiatives, including the adoption of methanol-fueled vessels. MC2 is a Europe-based container and logistics operator with a global shipping network and a fleet capacity of nearly 3.9 million TEU. It manages regional logistics hubs and terminals, employing over 75,000 personnel across multiple continents. The company is privately owned and handles various cargo categories. MC3 is a major Asia-based shipping company with a fleet totaling approximately 1.8 million TEU in container vessel capacity. It focuses on long-distance international shipping routes and is vertically integrated with terminal and inland logistics operations. MC3 employs about 10,000 people, is publicly traded, and is headquartered in East Asia. These companies were selected not only due to data availability but also because their combined TEU capacity represents 40% of the world’s maritime container transport capacity during the study period. This ensures that a significant portion of the maritime transport industry is represented in the study.

To evaluate economic, environmental, and social performance, the decision matrix was first constructed. The formula in step 1 of the TOPSIS methodology was then applied to obtain the normalized decision matrix. The weighted normalized matrix was created by multiplying the normalized matrix values by the criteria weights for each evaluation year. After determining both the positive and negative ideal solutions, the Euclidean distances of each alternative to the positive and negative ideal solutions were calculated.

5.4.1. Economic Dimension Performances of Maritime Companies

The result of the evaluation in terms of economic dimension for each alternative was computed. Ideal, negative ideal distances and results were given in Table 8 for each year. MC2 has the highest (Ci+) value according to the economic dimension of sustainable development results for the year 2017. MC1 has the highest (Ci+) value according to the economic dimension of sustainable development results for the year 2018 and the same in 2019 in terms of economic sustainability performance. In comparison while MC1 has the lowest score in 2017 as 0.000, the score rose sharply to 0.99 in 2019. This shows us strategic investments or market positioning could move financial performance higher. MC3 performs well but a balanced non-competitive economy. It is inferred that while leaders such as MC2 preserve their leadership in sustainability, late starters like MC1 can catch up others if right strategies are implemented. Stability observed in MC3’s trend may supply a safeguard against volatility, but this situation can restrict competitive advantage in future. As a result, Table 8 underlines the continuous investment in economic capacity and the risks of remaining stable in competitive market.

Year /Company	2017			2018			2019		
	S_i^+	S_i^-	C_i^+	S_i^+	S_i^-	C_i^+	S_i^+	S_i^-	C_i^+
MC1	0.55049587	0.00000000	0.00000000	0.20753966	0.4820391	0.69903415	0.00480209	0.45631636	0.989586
MC2	0.00000000	0.55049587	1.00000000	0.44249138	0.2254978	0.33757702	0.44967468	0.085533267	0.15949813
MC3	0.17714449	0.4346275	0.71044034	0.53026166	0.0000000	0.00000000	0.09516039	0.44360847	0.82337437

Table 8. Ideal, Negative ideal Distances and Results of Economic Dimension

5.4.2. Environmental Dimension Performances of Maritime Companies

In the environmental performance analysis process in terms of environmental dimension each company was assessed. Ideal, negative ideal distances and results were given in Table 9 for each year.

Year /Company	2017			2018			2019		
	S_i^+	S_i^-	C_i^+	S_i^+	S_i^-	C_i^+	S_i^+	S_i^-	C_i^+
MC1	0.13261938	0.00000000	0.00000000	0.1391057	0.00000000	0.00000000	0.15023982	0.00000000	0.00000000
MC2	0.0699629	0.06947542	0.49825199	0.08902144	0.05452137	0.37982655	0.08875916	0.06432054	0.42017682
MC3	0.00000000	0.13261938	1.00000000	0.00000000	0.1391057	1.00000000	0.00000000	0.15023982	1.00000000

Table 9. Ideal, Negative ideal Distances and Results of Environmental Dimension

According to the environmental dimension of sustainable transportation findings, MC3 has the highest (Ci+) value for all years for which performances were examined. **For three years MC3, achieved a value of (Ci+) as 1.00000 and outperformed its competitors regarding environmental performance.** This result indicates that MC3 invested heavily in environmental initiatives like fuel-efficiency. In contrast MC1 rated lowest (Ci+) value as 0.000 showing a lack of environmental integrity while reporting. MC2's moderate values indicate gradual environmental developments because regulatory adaptation can cause deceleration of transformative environmental leadership. The performance gap between MC3 and MC1 underlines that environmental applications are not adopted evenly accross all companies and as a result sectoral imbalances can be observed. Overall, the findings indicate the role of regulatory pressure and corporate devotion in environmental sustainability.

5.4.3. Social Dimension Performances of Maritime Companies

Year /Company	2017			2018			2019		
	S_i^+	S_i^-	C_i^+	S_i^+	S_i^-	C_i^+	S_i^+	S_i^-	C_i^+
MC1	0.48636859	0.02690801	0.05242399	0.49337031	0.0167254	0.03278875	0.49191933	0.09116164	0.15634473
MC2	0.06933407	0.41999798	0.85830874	0.09885361	0.4204773	0.80965198	0.08995609	0.49338823	0.84579247
MC3	0.05977651	0.48507525	0.89028848	0.0622646	0.49126349	0.8875132	0.1037485	0.49001434	0.82526946

Table 10. Ideal, Negative ideal Distances and Results of Social Dimension

The result of the evaluation in terms of social dimension for each alternative was computed. Ideal, negative ideal distances and results were given in Table 10 for each year.

According to the social dimension of sustainable transportation results for 2017 and 2018, MC3 has the highest (Ci+) value. MC2, on the other hand, has the highest (Ci+) value for 2019. The shift between MC2 and MC3 from 2017 to 2019 emphasizes that corporate priorities can fluctuate social sustainability performance. Both MC2 and MC3 passed MC1 whose ratings were persistently low and never higher than 0.16 over all years. This allocation shows MC2 and MC3 give more importance on occupational safety and gender equity practices than MC1. The weak performance of MC1 may be due to greater work-accident rates or a weak emphasis on social sustainability in reports. These findings present that occupational safety and diversity policies can make a significant difference in social sustainability performance.

5.5. Interpretation of Findings

Company MC3 ranked highest in environmental sustainability, possibly due to greater investment in green technologies. In contrast, MC2's top ranking in economic criteria reflects a cost-efficiency-oriented approach. These performance differences suggest that companies adopt distinct sustainability strategies, which may influence their market positioning and stakeholder perceptions. For decision-makers, this variation highlights the need to balance conflicting priorities when evaluating sustainability performance.

Compared to previous research on marine sustainability performance, our findings show that experts place greater priority on economic criteria, which contradicts the balanced approach recommended by Benamara et al. (2019). This disparity might be attributed to a company-level approach that prioritizes operational cost-efficiency and financial rewards. Unlike prior studies that evaluated sustainability from a port-centric viewpoint (Asgari et al., 2015) or at the national policy level (Lee et al., 2019), this analysis incorporates maritime company-level performance data across three years, providing a longitudinal, multi-dimensional view. This research enhances previous knowledge by operationalizing a transparent, reproducible evaluation method for corporate-level maritime sustainability using a structured AHP-TOPSIS model that considers criteria linked to the SDG frameworks.

While the findings clearly show that the economic dimension was prioritized, this contradicts the balanced integration of economic, environmental, and social dimensions of sustainability. This may be due to severe cost pressures and competitive dynamics within the maritime transportation industry, which drive a focus on profitability and operational efficiency over social responsibility. Additionally, regulatory frameworks within the maritime sector have emphasized economic efficiency and environmental pollution reduction rather than social equity, further reinforcing this imbalance. From a theoretical perspective, this reveals a persistent gap between the sustainability triple bottom line ideal and actual industry practices. From a practical perspective, policymakers may need to introduce stronger incentives, and industry leaders may require stricter reporting requirements to elevate the role of social sustainability in maritime transport.

This study's unexpected conclusion was the minimal weight attributed to the social dimension of sustainability. While social aspects such as occupational safety, gender diversity, and employee well-being are widely recognized as essential components of sustainability frameworks (Colantonio, 2009), the maritime experts consulted for this study consistently prioritized economic and environmental criteria. One possible explanation is that the sector is under regulatory and operational pressure to cut emissions and achieve cost-efficiency, which may lead to social issues being viewed as secondary. This finding is consistent with Lam and Lim's (2016) observation that social sustainability is still underdeveloped in the maritime sector, indicating the need for improved awareness and stronger regulatory frameworks to highlight its importance in maritime sustainability.

6. CONCLUSION

The concept of sustainable development has been on the global agenda for many decades, with various efforts made to promote it worldwide. As a significant part of international transport, the maritime transport sector has also made considerable efforts to keep pace with these developments. Since sustainable development encompasses three key dimensions, it must be addressed equally across all of them. However, most studies in the literature have focused on only one dimension, and there is a lack of studies evaluating the sustainable development performance of maritime transport companies by considering all dimensions comprehensively. To address this gap, this study aims to identify performance criteria for sustainable maritime transport and to rank the significance of these criteria. Additionally, it seeks to determine which maritime transport company has been more successful in terms of sustainable development performance over the years.

The results of this study offer several contributions to both the literature and practice. One significant contribution is that it addresses all three dimensions of sustainable development, whereas most previous studies have focused on only one. This holistic perspective contributes to a better understanding of the sustainable development concept.

The maritime industry still prioritizes economic performance, while social sustainability receives less attention, and environmental sustainability is largely driven by emission regulations rather than company initiatives. Regulators can address this imbalance by developing policies that not only focus on reducing emissions but also encourage stronger measures in occupational safety, diversity, and social responsibility. Policy tools such as mandatory social sustainability reporting can help guide industry practices toward a more consistent understanding of sustainability.

From a managerial perspective, companies should recognize that long-term competitiveness depends on strengthening all three dimensions of sustainability. While efficiency and profitability remain important, companies need to allocate resources to employee welfare programs, develop diversity policies, and ensure transparent sustainability reporting. Maritime shipping companies should adopt holistic key performance indicators that integrate economic, environmental, and

social outcomes to meet stakeholder expectations. Similarly, by using these holistic indicators, cargo owners and freight forwarders, as key stakeholders, can encourage maritime shipping companies to incorporate social policies into their sustainability strategies.

However, the AHP results conflicted with some perspectives in the literature regarding the relative importance of the criteria. Although Benamara et al. (2019) argue that all dimensions of sustainable development should be considered equally, the results of this study indicate that the economic dimension is viewed as more important, while the social dimension is considered the least important in evaluating sustainable development criteria in the maritime transport sector. This finding may help explain why Lam (2015) emphasizes that the social component of sustainable development is underrepresented in the literature. The study also demonstrated how the TOPSIS method can be used to assess the sustainable development performance of maritime transport companies. By combining the AHP and TOPSIS methods, it was possible to determine both the relative importance of sustainable development criteria and which maritime transport companies have performed better over the years in meeting these criteria.

This study makes a theoretical contribution by incorporating all three dimensions of sustainability criteria into a two-stage MCDM framework that includes AHP and TOPSIS. The model's dimensional structure, which categorizes indicators into economic, environmental, and social groups, highlights the importance of multi-criteria decision-making tools in evaluating maritime sustainability. Thus, the study provides not only empirical insights but also contributes to the theoretical understanding of structured performance evaluation in complex transportation systems.

This research is subject to several limitations. Therefore, the results must be interpreted with caution, and these limitations should be considered. Due to a lack of data, we limited the scope of the analysis. Sustainability reporting among maritime transport companies has become common in recent years; however, only a few companies have published annual sustainability reports for several years. As a result, only three companies from the maritime transport industry operating in the container transportation sector were chosen, either due to a lack of published reports or insufficient tangible data in the reports. Additionally, the sustainable development performance of the chosen maritime transport companies was evaluated only for the three years between 2017 and 2019 because of insufficient data before that period. The study focuses on 11 sub-criteria for sustainable development performance evaluation due to limited available data. The proposed assessment framework can be used by decision makers and policymakers in maritime companies to evaluate sustainability performance at the company level. Furthermore, performance evaluation and reporting procedures can become more transparent and consistent through the use of multi-criteria decision-making tools such as AHP and TOPSIS.

Future studies should address these limitations by including a wider range of companies from different geographical regions to account for regional differences in sustainability practices. Placing reports within a legal reporting framework will improve data accessibility and quality, contributing to more accurate results in future research. Extending the study period will also enable a more accurate assessment of long-term sustainability. Comparing the maritime container transportation industry with bulk cargo or tanker sectors can provide additional perspectives. Finally, in addition to company reports, using third-party sustainability ratings, reports, or stakeholder surveys can enhance the robustness of the findings.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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