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Identifying Key Financial, Environmental, Social, Governance (ESG), Bond, and COVID-19 Factors Affecting Global Shipping Companies —A Hybrid Multiple-Criteria Decision-Making Method

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Abstract: The international shipping industry is the largest transportation system in the world. However, shipping stock prices were highly volatile during the 2020–2021 COVID-19 pandemic. The purpose of this study is to identify the causal relationships of the four dimensions (financial performance, bond financing, environmental, social, governance, and COVID-19.) and 20 criteria affecting the sustainability of global shipping companies. The research scope includes a sample of nine listed international shipping companies accounting for 49% of the global market share with data collected from 2010 to 2020. Survey responses from 15 investment experts were also obtained. We applied a hybrid multiple criteria decision-making (MCDM) method integrating the Decision-Making Trial and Evaluation Laboratory (DEMATEL), analytic network process, and modified VlseKriterijumska Optimizacija I Kompromisno techniques to be the DANP-mV model to identify the causal relationships among the dimensions and criteria, providing ways of narrowing the performance gaps of shipping companies. The results indicate that financial performance is the main cause affecting COVID-19 and ESG practices. The ESG practices influence bond financing. The largest performance gaps across shipping companies include earnings per share (EPS), yield to maturity, corporate social responsibility (CSR), and timely delivery. The findings of this study suggest that shipping companies may focus on gross profit margin to improve EPS, term to maturity to enhance yield to maturity, social distancing policy to meet timely delivery, and the board size to enhance corporate social responsibility (CSR). The outcome of this study aids shipping companies in prioritizing their resources and investors in selecting shipping company stocks in response to COVID-19.

Keywords: shipping company; financial performance; COVID-19; ESG; bond financing; multiple-criteria decision making; Decision-Making Trial and Evaluation Laboratory (DEMATEL)

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1. Introduction

The international shipping industry represents the largest logistics provider in the world. Approximately 80% of global freight is carried by sea, and the industry serves as a crucial link in global supply chains and grants countries access to international markets [1]. The United Nations (UN) [1] projected that the global maritime trade would grow by 3.5% annually from 2019 to 2024, eventually carrying 11 billion tons of goods. Approximately one-third of trade is on oil, gas, and petroleum products, and the remaining two-thirds of trade is on commodities (iron ore, coal, and grain) and merchandise. Therefore,

the provision of global food, raw materials, and energy heavily depends on international shipping, which continues to bolster the world economy.

The shipping industry has attracted investor attention because of its rapid growth relative to global production [2]. Grelck et al. [3] observed that investors earned a higher rate of return when their investment portfolios included the stocks of international shipping companies. This finding indicated that investors might benefit from diversifying their investment portfolios by investing in shipping stocks.

However, researchers have regarded sustainability to be a point of weakness for the shipping industry; this is because shipping companies must balance concerns regarding financial volatility, environmental impact, social responsibility, and long-term financing [4–8]. Prior studies used mostly financial performance to indicate the tangible value of the international transportation industry [9,10]. However, governments around the world have required listed companies to fulfill their responsibilities for the environment and society. In 2019, the worse global event affecting the developed and developing economies was the coronavirus disease (COVID-19) broke out. In March 2020, the global stock markets declined by 25% to 30%. The shipping companies' stock prices turned volatile during the 2020–2021 COVID-19 period. The global shipping companies faced a serious problem of maintaining their shipments on schedule due to the spread of the coronavirus. Prior studies rarely discuss the key factors that could help the global shipping companies stay sustainable during COVID-19 with the increasing demand for their social role.

Based on the literature, the sustainability of global shipping companies is affected by four dimensions. First, tangible financial indicators measure sipping companies' business sustainability, which is mostly a concern for investors. Common financial indicators include return on equity (ROE) and earnings per share (EPS). However, the sustainability and growth potential of shipping companies do not only rely on the common financial indicators for investors but also on these companies' abilities to sustain themselves through external funds during the difficult time of COVID-19.

Second, financial institutions tend to reduce loans for shipping companies during the COVID-19 crisis. Therefore, the ability of global shipping companies to raise funds in the capital markets determines the scale of future fleet expansion. Bonds are a crucial way of financing global shipping companies, with bond financing subject to the following four criteria: the term to maturity, yield to maturity, credit rating, and bond market value [11,12]. These criteria for bond financing received little attention before the COVID-19 crisis, despite the need for financing and fleet expansion to increase shipping companies' cash flows in the future. However, investors around the world began to value socially responsible investment (SRI), which considers not only financial returns but also companies' environmental and social impact.

Third, governments worldwide demanded listed companies to comply with the environmental, social, and governance (ESG) regulations, which implied additional costs for these companies. Although shipping companies must disclose their costs of operations, the costs related to ESG practices may be hidden and underestimated [13]. From the environmental perspective, shipping companies may replace older ships relying on high-pollution heavy sulfur oil with new ones operating on desulfurized oil [13]. In addition, shipping companies may renovate poorly maintained crew quarters to avoid cross-infection of COVID-19 among crew members sharing the same room [14,15]. From a social perspective, shipping companies can strengthen safety measures to protect their crew members [15]. From the governance perspective, shipping companies may elect professional independent directors to replace family members to improve corporate governance [16].

The ESG practices become increasingly important during the COVID-19 period [17]. A number of measurable factors influence shipping companies' performance, such as the presence of confirmed cases of COVID-19 among dockers and the occurrence of technical/human error (e.g., when the giant Evergreen container ship blocked the Suez Canal in March 2021), which lead to increased costs and freight rates [17]. In addition, further ESG enforcements planned by governments around the globe in 2022 tend to increase

shipping companies' operating costs. For instance, major international ports plan to restrict the entry of ships fueled with heavy sulfur oil in 2022 [18–20]. Thus, investors may forego shipping companies with weak ESG compliance and implementations [18]. In contrast, some shipping companies can profit from the pandemic by raising the freight rates in response to the tremendous increase in online purchases due to the COVID-19 lockdowns. Thus, this study addresses this neglect of ESG factors in the literature by identifying the essential criteria for the ESG dimension that affect the performance of shipping companies during the 2019 to 2020 period of the COVID-19 pandemic from an investor's perspective.

Fourth, shipping companies often face adverse events on land and sea. The COVID-19 pandemic often prevented shipping companies from transporting goods on schedule. These companies coped with such challenges by developing proactive measures such as formulating emergency response plans, protecting employee safety, and ensuring timely delivery during the COVID-19 pandemic. [21–23]. For example, the managers of shipping companies enlarged the distance between the beds in the crew dormitory, ensuring that each crew member had his or her own living space to prevent the spread of infection. During the pandemic, when an individual was detected with COVID-19, the shipping companies would ferry the entire crew back to their previous ports of call as rapidly as possible. Such practices increased operating costs and oil expenses and thus decreased corporate earnings. However, if a crew member is infected, the ship must return to its previous port of call to exchange crew members, which may negatively affect the cost of navigation and timeliness of delivery. The ship may then be delayed and must increase its speed for unloading to occur on the specified date, thereby driving up the fuel cost. During the COVID-19 period, these factors affecting costs were not reflected in the financial statements, obscuring the reality of the situation.

Moreover, undertaking these plans and actions lead to companies outperforming their rivals in the financial results during the next quarter. In addition, if an international shipping company has more effective emergency response plans for managing port congestion and infections among dock workers, it is likely to be more competitive, earn more revenue, and results in lower ship usage turnover rates, all of which improve cash flow and financial performance and allow the company to become a more attractive target for investment.

Prior studies mainly invested the impact of corporate social responsibility (CSR) on shipping companies and compared the financial performance and efficiency of the three shipping segments (tankers, dry bulk, and container). [15,16,24–27]. These studies primarily used ROE, return on assets (ROA), and operating income to measure the financial performance of the shipping companies. However, shipping companies have faced the challenge of sustainability from multiple perspectives, which leads to research gaps. For example, governments around the world urged all listed companies to implement ESG practices. In addition, the shipping companies found it difficult to receive bank loans after the 2008 global financial crisis. The recent 2020–2022 COVID-19 pandemic required shipping companies to cope with the obstacles of transporting goods. Therefore, evaluating global shipping companies from one perspective seemed to be inadequate. This study bridges the research gaps not only by adopting four dimensions and 20 criteria but also by suggesting areas for improvement, thus providing a holistic view of the global shipping industry.

The purpose of this study is to identify the key factors from four dimensions (financial performance, bond financing, ESG, and COVID-19) and twenty criteria affecting the sustainability of global shipping companies, thus ranking these companies based on performance gaps. Based on the Delphi method described by [28], we surveyed 15 investment experts and collected the data of nine international listed shipping companies headquartered in Europe, Asia, and the U.S.A from 2010 to 2020. These nine large shipping companies account for nearly 49% of the global market share in terms of market capitalization,

with seven of them ranked among the top 10 shipping companies in the world. We applied a hybrid multiple criteria decision (MCDM) model integrating the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method, analytic network process (ANP), and modified VlseKriterijumska Optimizacija I Kompromisno (VIKOR) techniques, known as the DANP-mV model to analyze the collected data [29].

This study contributes to the shipping industry literature in three ways. First, we developed four dimensions and twenty criteria to include both quantitative and qualitative indicators to analyze the data, thus providing a holistic view of the shipping companies. Second, we applied a hybrid MCDM model named the DANP-mV model to the data. This novice model not only identifies the causality of the four dimensions and 20 criteria but also computed the gap of each shipping company from its actual to the aspiration (ideal) level based on all four dimensions and 20 criteria. Third, we are among the first researchers to examine the effect of the 2019–2021 COVID-19 pandemic on the global shipping industry. Thus, we can rank the nine shipping companies based on their performance gaps considering the challenging COVID-19 crisis. These findings benefit both managers in improving their performance and investors who are considering incorporating shipping companies' stocks into their portfolios.

The findings of this study indicate that financial performance is the most influential dimension regardless of the increasing importance of ESG, implying that greater financial performance enables shipping companies to cope with the COVID-19 pandemic better. The COVID-19 pandemic is the second most influential dimension that affects the ESG and bond financing, suggesting that the pandemic puts shipping companies under pressure to implement ESG practices and bond issuance. Lastly, the ESG dimension affects bond financing, indicating that shipping companies with ESG initiatives can attract more bond investors.

The remainder of this paper is structured as follows. Section 2 presents a literature review and develops dimensions and criteria affecting the global shipping industry. Section 3 details the data and model. Section 4 provides the empirical results and a discussion of the implications. Section 5 concludes the study, explains the limitations and suggests future studies.

2. Literature Review

2.1. Investment Portfolio Theory

Markowitz [30] developed modern portfolio theory, which has greatly aided investors in making asset allocation decisions. This theory evaluates not only the return but also the risk of an investment. Modern portfolio theory is employed to either maximize the expected return of a portfolio at a given level of risk or minimize risk for a given level of expected return. This theory recommends asset diversification to hedge against market risk or risks unique to a specific company or industry. Diversification reduces risk when the return among different assets is negatively correlated. Therefore, an investment portfolio must include a wide range of securities with collectively lower risk than any individual stock.

The shipping industry has received increasing global attention as the major transportation system delivering oil, gas, merchandise, and raw materials [31]. Sea transportation provides a safe and low-cost means of transporting goods. Moreover, investors favor the shipping industry for its rapid growth and high return [32]. The shipping sector has exhibited continual growth in the last two decades and, as of 2000, is one of the fastest-growing industries as a result of globalization [33]. This sector profits from the growth of the world economy and world trade. From 2011 to 2016, the growth rate of seaborne trade averaged 3.8%, which exceeded the 2.3% average growth rate of global gross domestic production [2]. The expansion of global trade increased demand for transportation services; therefore, seaborne trade, as a result of its lower costs compared with other means of transportation, has increased markedly since 2000 [31].

The rates of return on the stocks of shipping companies have remained high since the increase in the number of listed international shipping companies from 2001 onward [34]. According to Albertijn et al. [8], the average annual return of the 30 largest listed shipping companies worldwide from 2002 to 2011 was 18.6%. Moreover, measures of the corporate systematic risk (beta) of shipping companies indicate that an investment portfolio including shipping stocks may offer substantial diversification for investors [8]. Similarly, Grelck et al. [3] demonstrated that adding a shipping stock to a traditional stock-and-bond portfolio enables investors to achieve a higher return/risk ratio; this is because shipping companies exhibit industry-specific systemic risk in the Standard and Poor's (S&P's) 500 index.

Although an increasing number of investors favor shipping stocks, the high cyclicality and volatility of freight rates in response to the changing demand from world trade could lead to substantial investment loss [21,35]. Shipping companies are generally exposed to four categories of risks, namely financial risk (poor financial performance), default risk (failure to pay bond interest and principal), business risk (inability to comply with regulations), and market risk (reduction in a firm's value resulting from a distressed market, such as that during the COVID-19 pandemic) [22,35–37].

2.2. Financial Performance

The literature has largely used profitability to measure firm performance. Markowitz [30] argued that investors must consider the return and risk of an investment. Researchers have mostly assessed the return of investment using profit, ROE, return on assets (ROA), and EPS domains. Sroufe and Goalakrishna-Remani [24] applied structural equation modeling (SEM) to determine the impact of social sustainability on the financial performance of Fortune 500 companies. They used ROA, return on investment, and net profit margin to measure financial performance and identified a positive influence of social sustainability on these financial ratios.

Tsionas et al. [25] noted that shipping companies have gradually transitioned from being family-owned entities to being publicly listed ones. They studied the impact of ownership concentration (shares owned by family or public investors) on firm performance of 107 globally listed shipping companies using ROA and ROE indicators. The results revealed a nonsignificant relationship between ownership concentration and firm performance from an investor perspective. Kang et al. [38] applied the panel regression method to identify the key factor affecting firm value (for use as an indicator) in an analysis of 64 shipping companies worldwide. The results indicated that investor perceptions of shipping companies are shaped the most by profitability as measured using ROE rather than using asset growth or liquidity.

Haider et al. [21] studied the corporate failure and financial performance of globally listed shipping companies from 1992 to 2014 using logistic regression. They adopted financial ratios from five categories, namely liquidity, profit, asset efficiency, cash flow, and market ratio, to measure firm performance and discovered that liquidity was the most critical indicator for bank failure. Woo et al. [39] applied the meta-frontier approach to compare inputs, such as assets and capital expenditure, against outputs, such as revenue and net income, to estimate the operating efficiency of the global shipping companies from 2001 to 2013. The empirical evidence indicated that dry bulk shipping firms were more capable of optimally using a set of given inputs to achieve maximum outputs than container shipping companies.

2.3. Bond Financing

Shipping finance refers to shipping companies' access to funds [39]. The shipping industry is highly capital-intensive, with the source of funds often a pressing concern of shipping company managers [40]. The 2008 global financial crisis and the ensuing decline in freight rates further emphasized the importance of financing for shipping companies attempting to sustain their business [19,23].

Alexandridisa et al. [19] reported that the aggregate amount of funds invested in constructing new vessels was more than USD1.5 trillion in the global shipping industry. For example, the acquisition of a 5-year-old Capesize vessel cost a shipping company approximately USD24 million in 2016 [40]. The top ten shipping companies owned fleets of ships valued at USD450 billion in 2016. Hence, shipping companies take on much debt when building or purchasing new and more efficient vessels to replace obsolete ships.

On the realization that bank loans could not satisfy their funding needs, shipping companies began to issue a large amount of high-yield bonds to raise funds after 2010 in response to the growing demand for shipping services [34,40]. Kavussanos and Tsouknidis [22] stated that professional investors, including mutual fund managers, favor the inclusion of shipping bonds for creating a well-diversified portfolio. However, the shipping industry is highly cyclical because of the volatility of freight rates; therefore, the bonds issued by shipping companies were, at the time of that study, regarded as being "below investment grade." The spread of shipping bonds represents premiums over risk-free rates, reflecting high risk [22,23].

In the literature, the spread of the new high-yield bonds of shipping companies has been largely determined through credit rating, term to maturity, yield to maturity, and issue amount [22,23,41]. Credit ratings are provided by at least two of the three major credit rating agencies, namely the S&P 500 (AAA, AA+, BBB+, and so on), Moody's credit rating (Aaa, Baa, Ba, and so on), and the Fitch rating (AAA, BBB, BB+, and so on), and contain information on the ability of shipping companies to make timely payments to bondholders. Investors use credit rating to measure the probability of default, which reflects the ability of shipping companies to sustain future cash flow and their vulnerability to economic cycles. Investors are most concerned with shipping companies' ability to pay interest during the payment period and with the rate of return from shipping bonds over a particular period of time [41].

A longer term to maturity generates a higher bond yield for investors and, thus, a higher cost of capital for the shipping companies [23]. The bond yield to maturity is defined as the percentage of the rate of return on a bond held by investors who purchased the bond at the market value until maturity [41]. A higher return for the investors affords the shipping companies a greater chance to raise funds.

During economic shocks, many companies face financial difficulties. For example, the Korean shipping company Hanjin Shipping filed for bankruptcy in August 2016, underscoring the need for shipping companies to manage their debts effectively [13]. Investors and governments could benefit from monitoring shipping companies' debts in the international market to reduce possible default risk [22].

2.4. ESG practice

Freeman's stakeholder theory [42] maintains that managers must pay attention to all individuals involved in an organization. Furthermore, investors tend to assign less value to firms that do not behave appropriately toward their stakeholders. In 2005, the UN announced the PRI, which emphasized ESG concerns [15] and the capacity of the ESG evaluation system to reward long-term responsible investments to the benefit of companies, the environment, and society.

Kotsantonis et al. [17] argued that investors are increasingly reviewing ESG practices and analyzing corporate data to evaluate whether companies that implement ESG initiatives can yield high earnings. Consequently, the number of companies reporting ESG information grew from 20 in the early 1990s to 8500 by 2014. In 2016, more than 1400 institutional investors with approximately USD60 trillion in assets under their stewardship committed to considering corporate ESG performance and data when constructing their investment portfolios [17].

The IMO, a global regulation-setting organization for international shipping, incorporated the UN's SDGs into its strategic goals for 2018 to 2023 and requested at least a 40% reduction in CO_2 emissions by 2030 (from those in 2008) [43].

Subsequently, shipping companies have played a vital role in facilitating the UN's sustainability concepts through the adoption of ESG practices [4,5]. Fasoulis and Kurt [5] asserted that improving ESG practices is key to increasing stakeholders' perceived value. Similarly, Kotsantonis et al. [17] determined that companies with above-average ESG scores outperformed other firms in terms of operating income and stock market return.

The major environmental protection concerns in the shipping industry relate to vessel and port CO_2 emissions, water and air pollution, the handling of waste and wastewater, and disposal of shipping assets [4,44]. The increase in the number of shipping routes and traffic flows in maritime ports exerts a direct environmental impact on the ecology around routes and hubs [5,45]. Lirn et al. [10] applied SEM to analyze the survey responses of 45 participants from Taiwanese shipping companies. The results revealed that shipping companies with green policies, ships, and suppliers could improve their form performance in both environmental and financial domains.

The social dimension of the ESG dimension encompasses employee welfare, work environment safety, maritime education and training, and contribution to the community [44,46,47]. Lee et al. [6] demonstrated that the social dimension of the ESG dimension is closely related to the environment, arguing that this dimension was being increasingly examined due to the effect of ship exhaust on some ports or cities worldwide and the risk of lung cancer and heart-related diseases among employees and citizens.

Studies have disagreed regarding the effect of corporate social responsibility (CSR) activities on shipping company performance. Some researchers have reported that shipping companies with CSR policies and practices stand out from the competition and are perceived to be benchmark organizations in the industry. Consequently, CSR enhances the financial performance of these shipping companies [13,47,48]. However, other researchers have disagreed. For example, Yuen et al. [49] noted that CSR policies trade-off against organizational efficiency and profit-maximizing objectives. Because changing freight rates strongly affect the shipping industry, shipping companies tend to pursue cost-cutting strategies, such as hiring low-cost labor and ignoring employee training responsibilities [26]. Such practices often negatively affect labor standards and lead to safety and environmental accidents. Tang and Gekara [14] examined the CSR adoption of the top 15 container shipping companies that receive 80% of the share of the global container shipping market. They observed that these shipping companies emphasized environmental protection, such as CO_2 emission reduction and employee welfare in terms of individual safety, education, and training. The findings further revealed that these shipping companies proactively implemented environmentally friendly practices (e.g., reducing emissions) to cater to their environmentally conscious customers. By contrast, because employee welfare is less visible to customers, the shipping companies only did the minimum to adhere to labor laws and regulations.

The literature has analyzed the governance of a firm from the two broad categories of ownership and board composition. Alexandridis et al. [19] argued that corporate governance is crucial for listed shipping companies; this is because these companies raise an increasing amount of funds from public investors in the form of bonds and equity. Corporate governance is a legal and institutional mechanism implemented to achieve the separation of ownership and to address the agency problem, which refers to the conflict between shareholders and managers [27], allowing managers to align their interests with shareholders.

However, the literature has been inconsistent regarding the effect of corporate governance, particularly ownership structures and board-of-director characteristics, in the shipping industry. Tamayo-Torres et al. [12] examined the relationship between the ESG factors and firm value using the data of 500 US and European firms for the 2008–2010 period. The results indicated that environmental and governance factors had a nonsignificant effect on firm value, with social performance negatively related to firm value. Siminica et al. [18] explored the interaction between the economic, environmental, and social dimensions, financial performance (measured using ROA and ROE), and corporate

governance. They used SEM to analyze the data of 614 large companies from the European Economic Area for the 2013–2017 period and determined that corporate governance positively influences the economic, social, and environmental outcomes of shipping companies.

Company-founding family members traditionally owned shipping companies, playing the dual role of chairperson and chief executive officer (CEO) to represent the interests of the family [19]. For example, family ownership effectively reduced agency costs through the common commitment to long-term firm development. Furthermore, Syriopoulos and Tsatsaronis [50] identified a positive relationship between family ownership and financial performance.

An increasing number of shipping companies have applied for public listing after 2008 because of the need for substantial funding. The public ownership of shipping companies enlarges the size of the board, extending director positions to people of various backgrounds from various fields of expertise. Andreou et al. [51] investigated the effect of corporate governance (ownership and board structure and CEO duality) on the firm performance of 32 US shipping companies. They discovered that some corporate governance mechanisms could reduce agency costs and improve financial performance. Similarly, Panayides [36] and Siminica et al. [18] have demonstrated that corporate governance featuring independent directors and a diverse board can enhance the value of shipping companies. However, other researchers have argued that family ownership can cause conflicts of interest between family and nonfamily board members, thus diminishing corporate value [9,17].

2.5. COVID-19

In December 2019, the coronavirus disease, or COVID-19, first emerged in China and, by July 2021, had quickly spread to 220 countries, infecting over 188 million people [52]. Most governments implemented lockdowns of various intensities in response [53]. The volume of cargo transported by sea shrunk considerably to halt the spread of the virus in vessels and at ports [54]. Few studies have investigated the specific reactions of the shipping industry to these events. Michail and Melas [53] examined how much the COVID 19 pandemic affected the shipping industry for the freight rates of tankers and bulk shipping vessels.

Research has demonstrated that COVID-19 affected both the global economy and financial markets and, consequently, world trade [54,55]. Freight rates decreased by 73%, 36%, and 30% for dry bulk, dirty tanker, and clean tanker shipping, respectively [55]. Additionally, Michail and Melas [56] reported that COVID-19 negatively affected the freight rates of dry bulk and dirty tanker shipping. Specifically, an increase of 1% in confirmed COVID-19 cases decreased the Baltic Dry Index by 0.03% and the Baltic Dirty Tanker Index by 0.046%, with the Baltic Dry Index and Clean Tanker Index negatively affected through demand-side economic factors.

Zheng et al. [57] used the ship's port of call to predict the navigation behavior of ships, determining that port call probability is positively correlated with ship deadweight. Their findings indicated that larger vessels stand idly at ports for less time and are accepted into ports more rapidly and that smaller vessels are used less frequently.

Ikram et al. [58] developed a framework integrating the dimensions of governance, the economy, the environment, society, energy consumption, and the COVID-19 pandemic to prioritize a set of criteria using the Delphi method and Analytical Hierarchy Process approach. They measured the effect of COVID-19 using the four sub-criteria of the presence of an emergency response plan, commitment to employee safety, just-in-time and lean delivery, and social distancing, revealing that the rapid spread of COVID-19 was the major factor disrupting shipping business sustainability. Many firms have designed a system to cope with new obstacles and concerns arising from the COVID-19 pandemic, and corporations have been advised to develop an emergency response plan to address

urgent matters and avoid organizational crises. In addition, the pandemic greatly disrupted the supply chains. Shipping companies have been forced to re-arrange their deliveries to avoid shipment delays. Finally, seafarers have been advised to strictly follow social distancing regulations to safeguard their health of their own and others [58].

The literature described the four dimensions with the going-concern assumption that the failure in any one of the categories would render the shipping companies unsustainable and lose their competitive edges in the long run. Specifically, financial performance determines the business sustainability of the shipping companies. Bond financing indicates the value of a shipping company perceived by investors and the firm's ability to obtain funds to expand and meet the market demand in the future. ESG practices impact the environmental sustainability and regulatory compliance of the shipping companies. The COVID-19 pandemic reflects the capabilities of the shipping enterprises to react rapidly to external adverse events.

Based on the literature, we developed four hypotheses:

Hypothesis 1 (H1): *Financial performance is a significant factor affecting global shipping companies;*

Hypothesis 2 (H2): *ESG is a significant factor affecting global shipping companies*;

Hypothesis 3 (H3): *Bond financing is a significant factor affecting global shipping companies;*

Hypothesis 4 (H4): *COVID-19 is a significant factor affecting global shipping companies*.

Therefore, we listed four dimensions and twenty criteria for analysis with the details and their definitions presented in Table 1.

Table 1. Dimensions, criteria, and their definitions.

Dimension	Criteria	Description
Financial Performance (D_1)	ROE (C_1)	Net income after tax divided by average equity
	Gross profit margin (C_2)	Gross profit divided by net sales
	Profit margin after tax (C_3)	Net income after tax divided by net sales
	Net operating profit margin (C_4)	Operating income divided by net sales
	EPS (C_5)	Net income after tax divided by the number of outstanding common shares
Bond Financing (D_2)	Term to maturity (C_6)	Number of years till the bond reaches maturity
	Yield to maturity (C_7)	Rate of return on a bond held by investors until maturity
	Credit rating (C_8)	Credit rating received by the shipping company as the bond issuer from the three major credit rating agencies
	Bond market value (C_9)	Current market price of the bond multiplied by the number of outstanding bonds
ESG (D_3) (Governance)	Ownership by internal parties (C_{10})	Percentage of stock ownership held by internal parties such as the board of directors and supervisors
	Proportion of independent directors (C_{11})	Percentage of independent directors in the total number of board directors
	Board size (C_{12})	Total number of board directors

ESG (D_3) (Environmental)	Air pollution (C_{13})	Air pollution prevention system used by shipping companies based on regulations
	Reduction of CO_2 emissions (C_{14})	Level of reduction in CO_2 emissions achieved by shipping companies
ESG (D_3) (Social)	Employee education and training (C_{15})	Training programs provided by shipping companies for employees
	CSR (C_{16})	Degree of disclosure of their CSR activities by shipping companies
	Emergency response plan (C_{17})	Emergency action plan developed by shipping companies to respond to any emergency
COVID-19 (D_4)	Employee safety (C_{18})	COVID-19 pandemic preventive measures for employees
	Timely delivery (C_{19})	Ability of shipping companies to deliver goods on time
	Social distancing (C_{20})	Employees maintain a distance of at least 2 m from each other to reduce the risk of contracting COVID-19

2.6. Method

Prior studies mostly applied statistical methods such as regression and stochastic frontier production function to assess the performance of shipping companies [15,16,24–27]. These conventional models rely on assumptions that all factors are independent and of equal importance. In contrast, the MCDM model identifies the importance of each and interdependence among factors. This study developed a hybrid MCDM model incorporating DEMATEL, ANP, and modified VlseKriterijumska Optimizacija I Kompromisno (VIKOR) methods to be DANP-mV method [29].

The DEMATEL method, developed by the Science and Human Affairs Program of the Battelle Memorial Institute, Geneva Research Centres, between 1972 and 1976, separates criteria into causes and effects and distinguishes the interdependence among criteria to create an influential network relationship map (INRM) [59]. The ANP method developed by Saaty [60] provides the network of the criteria in the form of a matrix.

Yang et al. [61] integrated the DEMATEL and ANP methods to form the DANP model, which manages the problems of interdependence and feedback among the criteria. The DANP method generates the INRM and influence weights for all criteria, signifying each criterion's importance.

Opricovic [62] developed the VIKOR method based on the concept of compromise programming. This method calculates a negative ideal solution (worst level) and a positive ideal solution (best level) and then ranks the alternatives based on their closeness to the ideal solution. However, the VIKOR method only compares the currently available alternatives using their minimum and maximum values. Therefore, Liou et al. [63] proposed the modified VIKOR method, which not only ranks the currently available alternatives to address areas for improvement but also identifies the performance gap, allowing the alternative to reach the aspiration level (the best possible solution for each alternative). Qu et al. [64] further integrated the VIKOR method in their DANP-mV model, which involves calculating the gap of each alternative from the aspiration level.

Previous researchers used the DANP-mV models to solve real-world problems by prioritizing options and obtaining performance gaps [64–66]. Qu et al. [64] applied a modified DANP-mV model to improve the quality of life for rural residents of a village in China. Lin et al. [65] employed the DANP-mV model to compare the long-term aging health care systems in Taiwan. Liu and Liu [66] adopted this model to find the most important training courses for travel agents who suffered greatly amid the COVID-19 pandemic. These authors used the DEMATEL method to clarify the interrelationships among

the criteria, the DANP method to calculate the influential weights, and the modified VIKOR method to obtain gap values. Based on prior studies, this study adopted the DANP-mV model to solve a complex real-world world regarding the sustainability of global shipping companies.

3. Methodology

3.1. Data and Sample

We first selected 15 listed shipping companies to validate the 4 hypotheses [32,67,68]. After removing the shipping companies with unavailable or missing information, we obtained the data for nine shipping companies from Bloomberg for the 2010–2020 period. Table 2 describes the characteristics of the nine globally listed shipping companies used for our analysis.

Table 2. Descriptions of nine global shipping companies

Seq.	Company Name	Headquarter	Description	Market Share Market Capitalization, 2020
1	Shipping Company A	Denmark	Founded in 1904; the largest shipping company in the world; focused on container transportation and oil exploration; has over 4 million twenty-foot equivalent units (TEU) and 677 ships.	16.9%
2	Shipping Company B	China	Founded in 1961; largest shipping company in China; the third-largest shipping company in the world; services cover 30 provinces in China and many countries in Europe, America, Asia, and Africa; engaged in container and dry bulk transportation; has 2.9 million TEU and 487 ships.	12.5%
3	Shipping Company C	Germany	Founded in 1970; the fourth-largest shipping company in the world with the merger of Chilean and German shipping companies; focused on container transportation; has 1.7 million TEU and 240 ships.	7.2%
4	Shipping Company D	Taiwan	Founded in 1968; largest shipping company in Taiwan; signed a letter of intent with other international maritime cooperation and established "OCEAN Alliance"; focused on container transportation; provides logistics services including terminal loading, unloading, and inland transportation services; the seventh-largest shipping company in the world; has 1.2 million TEU and 196 ships.	5.3%
5	Shipping Company E	South Korea	Founded in 1976, the largest shipping company in South Korea since the bankruptcy of Hanjin Shipping Company; accounts for the largest proportion of South Korean exports; the eighth largest shipping company in the world; has 0.65 million TEU and 69 ships.	3.0%
6	Shipping Company F	Taiwan	Founded in 1972; second-largest shipping company in Taiwan; the ninth-largest shipping company in the world; focused on container transportation; provides warehouse and terminal operations, as well as insurance, cargo consolidation, container transportation, loading, unloading, and logistics service; has 0.6 million TEU and 91 ships.	2.6%
7	Shipping Company G	Taiwan	Founded in 1965; provides extensive service network in the Far East; 90% of its revenue accounted for by the Asian markets; higher profits from offshore routes than ocean ones; the third-largest shipping company in Taiwan; the	1.3%

			10th-largest shipping company in the world; has 0.28 million TEU and 105 ships.	
	Shipping Company H	Hawaii, U.S.A.	Founded in 1882; listed on the New York Stock Exchange; provides shipping services mainly in Pan Pacific starting from the Hawaiian Islands; has 0.062 million TEU and 28 ships.	0.3%
9	Shipping Company I	China	Founded in 2002; listed in Hong Kong; focused on crude oil shipping services, container ship time chartering, dry bulk ships, vessel technology management; has 0.0598 million TEU and 36 ships.	0.3%

3.2. Demographics of Experts

This study distributed survey questionnaires to 15 experts with considerable experience in investment and who were working in 12 large financial institutions in Taiwan; the experts' demographic characteristics are listed in Table 3. We asked the experts to rate the importance of each dimension in their decision-making on shipping stock investments. All 15 experts responded to the survey.

Table 3. Demographics of the fifteen experts.

Category	Data	Number of Experts
Gender	Male	10 (67%)
	Female	5 (33%)
Age	41–45	3 (20%)
	46–50	6 (40%)
	51–55	4 (27%)
	56–60	2 (13%)
Position	Deputy General Manager	5 (33%)
	Senior Vice President	6 (40%)
	Senior Manager	4 (27%)
Number of years in investment banking	16–20	6 (40%)
	21–25	5 (33%)
	26–30	4 (27%)

3.3. Model

This study adopted a hybrid MCDM model of the DANP-mV model, integrating the DEMATEL, ANP, and modified VIKOR methods. This model is divided into three stages, with one method applied in each stage [29,63,64].

During the first stage, we adopted the DEMATEL method to determine the influence network of the dimensions and criteria. During the second stage, we employed the DANP method to obtain the influential weight of each dimension and criterion. The four hypotheses (H1-H4) are tested during the first and second stages with the consideration of influence placed to/from each dimension and criterion and the degree of influence. During the third stage, we utilized the modified VIKOR method to compare the actual and the ideal levels to rank the selected shipping companies based their performance gaps. The results directed efforts to narrow the gaps.

Figure 1 depicts the framework of the hybrid MCDM model based on the study by Liou and Tzeng [29], followed by an explanation of each step in the three stages.

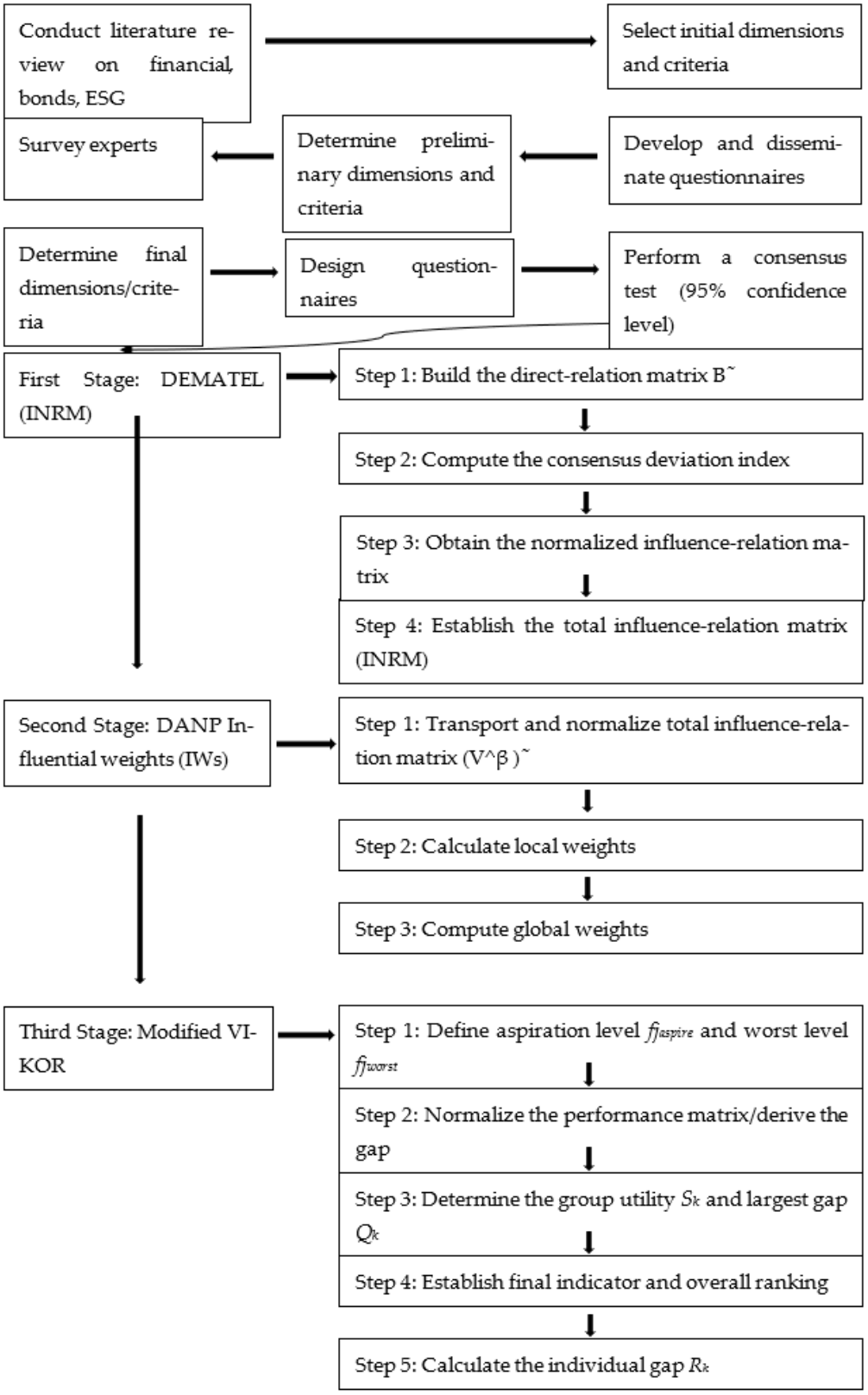


Figure 1. Framework of the hybrid MCDM model.

3.3.1. First Stage: The DEMATEL Method

During the first stage of this analysis, we adopted the DEMATEL method to identify the interdependence and connections of the 4 dimensions and 20 criteria through INRM.

All questions in the survey were rated on a 4-point Likert scale: 0 (*no influence*), 1 (*low influence*), 2 (*medium influence*), 3 (*high influence*), and 4 (*extremely high influence*). The DEMATEL method can be described in four steps:

Step 1: Build the direct-relation matrix

The direct-relation matrix $\tilde{B}$ is expressed as follows:

$$\tilde{B} = \begin{bmatrix} \tilde{b}_{11} & \cdots & \tilde{b}_{1j} & \cdots & \tilde{b}_{1n} \\ \vdots & & & & \vdots \\ \tilde{b}_{i1} & \cdots & \tilde{b}_{ij} & \cdots & \tilde{b}_{in} \\ \vdots & & & & \vdots \\ \tilde{b}_{n1} & \cdots & \tilde{b}_{nj} & \cdots & \tilde{b}_{nn} \end{bmatrix} \quad (1)$$

Step 2: Compute the consensus deviation index

We calculated the consensus deviation index (CDI), which represents the differences among the responses of the experts and indicates the consistency of the overall questionnaire results. The CDI threshold value was 5% [69,70]; if the value was less than 5%, the consensus consistency reached more than 95%. The CDI can be expressed in Equation (2):

$$\text{CDI} = \frac{1}{n(n-1)} \sum_{i=1}^{n} \sum_{j=1}^{n} \left(\frac{\left| \tilde{b}_{ij}^{G} - \tilde{b}_{ij}^{G-1} \right|}{\tilde{b}_{ij}^{G}} \right) \times 100\% \quad (2)$$

where n denotes the number of criteria, and G denotes the number of experts.

Step 3: Obtain the normalized influence-relation matrix

The normalized influence-relation matrix $\tilde{Y}$ was obtained through normalizing matrix $\tilde{B}$ in Step 1. Matrix $\tilde{Y}$ was derived from Equations (3) and (4).

$$\tilde{Y} = \text{m}\tilde{B} \quad (3)$$

$$\text{m} = \min \left\{ \frac{1}{max_j \sum_{i=1}^{n} b_{ij}}, \frac{1}{max_i \sum_{j=1}^{n} b_{ij}} \right\}, i, j \in \{1, \ldots, n\} \quad (4)$$

Step 4: Establish the total influence-relation matrix

The indirect effects of the problems continuously decreased with the powers of the matrix. We established the total influence-relation matrix $\tilde{S}$ using Equation (5).

$$\begin{aligned} \tilde{S} &= \tilde{Y} + \tilde{Y}^2 + \tilde{Y}^3 + \ldots + \tilde{Y}^v \\ &= \tilde{Y} \times (I + \tilde{Y} + \tilde{Y}^2 + \ldots + \tilde{Y}^{v-1}) \times (I - \tilde{Y}) \times (I - \tilde{Y})^{-1} \\ &= \tilde{Y} \times (I - \tilde{Y}^v) \times (I - \tilde{Y})^{-1} = \tilde{Y} \times (I - \tilde{Y})^{-1} \\ \text{Lim}_{v \to \infty} \tilde{Y}^v &= [\mathbf{0}]\, n \times n \end{aligned} \quad (5)$$

where I represents the unit matrix.

The total influence-relation matrix $\tilde{S}$ of the INRM can be derived using Equation (6) and (7), which yields the sum of each row and column, where "q" represents the total influence of all of the other criteria on one criterion, and "c" represents the total influence of one criterion on all other criteria. The term "q + c" indicates the total influence on and exerted by one criterion, signifying the degree of importance of the specific criterion in the network. The term "q − c" represents the net influence on or exerted by one specific criterion, indicating whether this criterion is a cause or effect. When q − c is positive, this criterion is a net cause, and when q + c is positive, this criterion is a net effect.

$$\tilde{S} = [q_i]_{n\times 1} = \left[\sum_{j=1}^{n} s_{ij}\right]_{n\times 1} = \left(q_1, \ldots, q_{i,} \ldots, q_n\right)_{n\times 1} \quad (6)$$

$$\tilde{c} = [c_i]_{n\times 1} = \left[\sum_{j=1}^{n} s_{ij}\right]_{1\times n} = \left(c_1, \ldots, c_{i,} \ldots, c_n\right)_{n\times 1} \quad (7)$$

3.3.2. Second Stage: The DANP Method

During the second stage of this analysis, we applied the DANP method, which proceeds in three steps.

Step 1: Transpose and normalize the total influence-relation matrix

We applied Equations (8)–(10) to normalize the total influence-relation matrix $\tilde{S}$ to obtain the normalized total influence relation-matrix $\tilde{S}^{\beta}$. Subsequently, the matrix $\tilde{S}^{\beta}$ could be transposed into $\tilde{V}^{\beta}$ using Equation (11).

$$\tilde{S} = \begin{bmatrix} \tilde{s}_{11} & \cdots & \tilde{s}_{1j} & \cdots & \tilde{s}_{1n} \\ \vdots & & & & \vdots \\ \tilde{s}_{i1} & \cdots & \tilde{s}_{ij} & \cdots & \tilde{s}_{in} \\ \vdots & & & & \vdots \\ \tilde{s}_{n1} & \cdots & \tilde{s}_{nj} & \cdots & \tilde{s}_{11} \end{bmatrix} = (S^l, S^m, S^g) \quad (8)$$

$$\tilde{S}_i = \sum\nolimits_{j=1}^{n} \tilde{s}_{ij} \quad (9)$$

$$\widetilde{S^{\beta}} = \widetilde{S}/\tilde{q} = \begin{bmatrix} \tilde{s}_{11}/\tilde{q}_1 & \cdots & \tilde{s}_{1j}/\tilde{q}_1 & \cdots & \tilde{s}_{1n}/\tilde{q}_1 \\ \vdots & & & & \vdots \\ \tilde{s}_{i1}/\tilde{q}_i & \cdots & \tilde{s}_{ij}/\tilde{q}_i & \cdots & \tilde{s}_{in}/\tilde{q}_i \\ \vdots & & & & \vdots \\ \tilde{s}_{n1}/\,\tilde{q}_n & \cdots & \tilde{s}_{nj}/\,\tilde{q}_n & \cdots & \tilde{s}_{11}/\,\tilde{q}_n \end{bmatrix} \quad (10)$$

$$\widetilde{V^{\beta}} = (\widetilde{S^{\beta}})^S = \begin{bmatrix} \tilde{s}_{11}/\tilde{q}_1 & \cdots & \tilde{s}_{i1}/\tilde{q}_i & \cdots & \tilde{s}_{n1}/\tilde{q}_n \\ \vdots & & & & \vdots \\ \tilde{s}_{1i}/\tilde{q}_1 & \cdots & \tilde{s}_{ij}/\tilde{q}_i & \cdots & \tilde{s}_{ni}/\tilde{q}_n \\ \vdots & & & & \vdots \\ \tilde{s}_{1n}/\,\tilde{q}_1 & \cdots & \tilde{s}_{in}/\,\tilde{q}_i & \cdots & \tilde{s}_{11}/\,\tilde{q}_n \end{bmatrix} \quad (11)$$

Step 2: Calculate the local weights

We limited the transposed total influence-relation matrix $\widetilde{V^{\beta}}$, raising the matrix to the x power until the $\widetilde{V^{\beta}}$ converged and became a stable matrix using Equation (12). We then obtained the local weights of the dimensions and criteria, termed the influence weights in the DANP model.

$$\tilde{V} = \lim_{x\to\infty} (\widetilde{V^{\beta}})^x \quad (12)$$

We computed the global weights by multiplying the local weights of each criterion and dimension using Equation (13).

$$V_k^g = V_{c\_k}^l \times V_c^l \quad (13)$$

3.3.3. Third Stage: The Modified VIKOR Method

During the third stage of this analysis, we employed the modified VIKOR method, which proceeded in five steps.

Step 1: Establish the aspiration level and worst value

We defined the aspiration level and worst level as the largest and smallest value, respectively, of the 2010 to 2020 data sample. The maximum and minimum value was the highest and lowest value, respectively, of the 10-year average. In the modified VIKOR performance matrix, we denoted the aspiration level as $f_j^{\ aspire}$ and the worst level as $f_j^{\ worst}$. The criteria were denoted as j (j = 1, 2,…, n). The positive and negative ideal levels were set as $f_j^* = \max f_{kj}$ and $f_j^- = \min f_{kj}$, respectively. The alternatives were denoted as k (k = 1, 2,…, m). We established the aspiration level and worst level using Equations (14) and (15).

$$f_j^{aspired} = (f_1^{aspired}, \dots, f_j^{aspired}, \dots, f_n^{aspired}) \quad (14)$$

$$f_j^{worst} = (f_1^{worst}, \dots, f_j^{worst}, \dots, f_n^{worst}) \quad (15)$$

Step 2: Normalize the performance matrix and calculate the gap

We normalize the performance values of the dimensions and criteria and then calculated the distance between these performance values and the aspiration level. The normalized distances represented gaps calculated using Equation (16).

$$[r_{kj}]_{m\times n} = [(|f_j^{aspired} - f_{kj}|)/(|f_j^{aspired} - f_j^{worst}|)]_{m\times n} \quad (16)$$

Step 3: Determine the group utility S_k and largest gap Q_k

The gap calculated in Step 2 was multiplied by the influence weights of the dimensions and criteria to calculate the average value of the smallest group utility S_k; the smallest S_k value represented the maximum group utility, which was calculated using Equation (17). Subsequently, we computed the largest gap Q_k for each alternative (individual regret degree) after incorporating the influence weights. A smaller Q_k indicated less serious objections and greater acceptance. The largest Q_k was calculated using Equation (18).

$$L_k^{p=1} = S_k = \sum_{j=1}^{n} w_j r_{kj} = \sum_{j=1}^{n} w_j(|f_j^{aspired} - f_{kj}|)/(|f_j^{aspired} - f_j^{worst}|) \quad (17)$$

$$L_k^{p=\infty} = Q_k = \max_j\{w_j r_{kj} | j = 1,2, \dots, n\} \quad (18)$$

Step 4: Establish a comprehensive integration indicator and rank the criteria

We integrated S_k and Q_k to obtain a comprehensive indicator using Equation (19) and ranked the shipping companies based on the results.

$$R_k = v(S_k - S^*)/(S^- - S^*) + (1 - v)(Q_k - Q^*)/(Q^- - Q^*) \text{ v} \in [0,1] \quad (19)$$

when $S^* = \min_k S_k$, $S^- = \max_k S_k$, $Q^* = \min_k Q_k$, $Q^- = \max_k Q_k$。

Step 5: Calculate the individual gap

We computed $S^* = S^{aspired} = 0$, which indicates that the gap equals 0 at the aspirational level and $S^- = S^{worst} = 1$ (worst level within the tolerance range) based on Equation (20).

$$R_k = vS_k + (1 - v)Q_k \quad (20)$$

4. Empirical Results and Discussion

4.1. Results of First-Stage Analysis Using the DEMATEL Method

In the first stage of our analysis, we used the DEMATEL method to obtain the direct-relation matrix (B) and total influence-relation matrix (S), both of which are presented in Table 4 for the four dimensions of financial performance, bond financing, ESG factors, and COVID-19 pandemic.

Table 4. Direct-relation matrix (B) and total influence-relation matrix (S) for the four dimensions.

B	**D_1**	**D_2**	**D_3**	**D_4**
D_1	0.000	3.600	2.800	3.000
D_2	2.667	0.000	2.000	1.800
D_3	2.667	2.133	0.000	2.667
D_4	2.867	2.267	2.800	0.000
S	D_1	D_2	D_3	D_4
D_1	1.281	1.544	1.434	1.431
D_2	1.187	0.957	1.087	1.062
D_3	1.306	1.256	1.023	1.231
D_4	1.371	1.317	1.302	1.059

Note: Consensus value = 98.51% > 95%. Source: own study.

Table 5 lists the direct-relation matrix (B) and total influence-relation matrix (S) for the five criteria (C_1, ROE; C_2, gross profit margin; C_3, profit margin after tax; C_4, percentage of operating income; and C_5, EPS factors) in the dimension of financial performance (D_1).

Table 5. Direct-relation matrix and total influence-relation matrix for criteria C_1–C_5.

B	**C_1**	**C_2**	**C_3**	**C_4**	**C_5**
C_1	0.000	1.867	2.267	2.067	2.467
C_2	3.000	0.000	3.200	3.467	3.133
C_3	3.067	1.733	0.000	2.200	3.333
C_4	2.933	1.933	3.400	0.000	2.667
C_5	2.600	2.133	2.467	2.400	0.000
S	C_1	C_2	C_3	C_4	C_5
C_1	0.662	0.596	0.793	0.720	0.822
C_2	1.112	0.652	1.098	1.026	1.118
C_3	0.950	0.656	0.733	0.810	0.964
C_4	0.987	0.696	0.988	0.700	0.972
C_5	0.891	0.653	0.863	0.792	0.721

Note: Consensus value = 97.85% > 95%. Source: own study.

Table 6 presents the direct-relation matrix (B) and total influence-relation matrix (S) for the four criteria (C_6, term to maturity; C_7, yield to maturity; C_8, credit rating; and C_9, bond market value) in the dimension of bond financing (D_2).

Table 6. Direct-relation matrix and total influence-relation matrix for criteria C_6–C_9.

B	**C_6**	**C_7**	**C_8**	**C_9**
C_6	0.000	3.200	2.867	2.600
C_7	3.067	0.000	3.133	2.533
C_8	1.867	2.267	0.000	2.667
C_9	2.200	2.533	2.933	0.000
S	C_6	C_7	C_8	C_9
C_6	1.776	2.201	2.365	2.138
C_7	2.035	1.941	2.387	2.139
C_8	1.633	1.793	1.745	1.803
C_9	1.797	1.965	2.161	1.725

Note: Consensus value = 98.36% > 95%. Source: own study.

Table 7 presents the direct-relation matrix (B) and total influence-relation matrix (S) for the seven criteria (C_{10}, ownership by internal parties; C_{11}, proportion of independent directors; C_{12}, board size; C_{13}, air pollution; C_{14}, reduction in CO_2 emissions; C_{15}, employee education and training; and C_{16}, CSR) in the dimension of ESG factors (D_3).

Table 7. Direct-relation matrix and total influence-relation matrix for criteria C_{10}–C_{16}.

B	**C_{10}**	**C_{11}**	**C_{12}**	**C_{13}**	**C_{14}**	**C_{15}**	**C_{16}**
C_{10}	0.000	3.133	2.400	1.133	0.933	2.267	2.533
C_{11}	2.600	0.000	2.933	1.400	1.267	2.067	2.600
C_{12}	2.867	3.000	0.000	1.467	1.533	2.267	2.467
C_{13}	1.267	1.600	1.600	0.000	3.333	1.733	3.267
C_{14}	1.267	1.333	1.400	3.600	0.000	2.000	3.267
C_{15}	2.267	1.400	1.533	1.667	1.867	0.000	3.067
C_{16}	2.200	2.133	2.133	3.133	3.267	2.667	0.000
S	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}
C_{10}	0.345	0.501	0.455	0.399	0.388	0.471	0.573
C_{11}	0.487	0.358	0.489	0.425	0.416	0.475	0.591
C_{12}	0.514	0.522	0.358	0.444	0.443	0.500	0.607
C_{13}	0.416	0.432	0.421	0.367	0.526	0.458	0.628
C_{14}	0.415	0.420	0.412	0.543	0.366	0.471	0.630
C_{15}	0.441	0.403	0.396	0.421	0.427	0.341	0.583
C_{16}	0.519	0.518	0.503	0.576	0.578	0.562	0.546

Note: Consensus value = 97.30% > 95%. Source: own study.

Table 8 lists the direct-relation matrix (B) and total influence-relation matrix (S) for the four criteria (C_{17}, emergency response plan; C_{18}, employee safety; C_{19}, timely delivery; and C_{20}, social distancing) in the dimension of COVID-19 (D_4).

Table 8. Direct-relation matrix and total influence-relation matrix for criteria C_{17}–C_{20}.

B	C_{17}	C_{18}	C_{19}	C_{20}
C_{17}	0.000	3.200	3.467	2.467
C_{18}	3.067	0.000	2.800	2.867
C_{19}	2.933	2.200	0.000	2.067
C_{20}	2.733	3.600	2.667	0.000
S	C_{17}	C_{18}	C_{19}	C_{20}
C_{17}	3.400	3.702	3.738	3.196
C_{18}	3.562	3.356	3.606	3.145
C_{19}	3.091	3.081	2.902	2.685
C_{20}	3.623	3.724	3.679	2.980

Note: Consensus value = 98.67% > 95%. Source: own study.

We obtained q + c, which indicated the degree of total influence on and exerted by each dimension and criterion. A higher-value q + c signified that the dimension or criterion was more influential than others, and the dimension or criterion with the highest q + c value played a central role in the network. The value of q − c represented the net influence, indicating whether this dimension or criterion was a cause or effect in the network; when the value of q − c was greater or less than zero, this criterion was a cause or effect, respectively. Table 9 lists the values of q + c and q − c derived from the total influence-relation matrix.

Table 9. Total influence (q + c) and net influence (q − c).

Dimension/Criteria	q	C	q + c (Centrality)	q − c (Cause and Effect)
D_1	5.690(1)	5.145(1)	10.835(1)	0.545(1)
C_1	3.593(5)	4.603(1)	8.195(5)	−1.010(5)
C_2	5.007(1)	3.254(5)	8.261(4)	1.753(1)
C_3	4.114(3)	4.475(3)	8.589(1)	−0.362(3)
C_4	4.343(2)	4.047(4)	8.391(3)	0.296(2)
C_5	3.921(4)	4.598(2)	8.520(2)	−0.677(4)
D_2	4.293(4)	5.074(2)	9.368(4)	−0.781(4)
C_6	8.480(3)	7.241(1)	15.721(2)	1.238(2)
C_7	8.503(1)	7.900(3)	16.403(1)	0.604(1)
C_8	6.973(4)	8.657(4)	15.631(4)	−1.684(3)
C_9	7.648(2)	7.805(2)	15.453(3)	-0.158(4)
D_3	4.815(3)	4.845(3)	9.66(3)	−0.03(3)
C_{10}	3.132(7)	3.136(3)	6.268(3)	-0.005(6)
C_{11}	3.240(3)	3.154(7)	6.395(2)	0.086(4)
C_{12}	3.387(2)	3.033(1)	6.420(7)	0.355(3)
C_{13}	3.248(5)	3.176(4)	6.424(4)	0.072(7)
C_{14}	3.258(6)	3.143(5)	6.401(5)	0.115(2)
C_{15}	3.011(4)	3.278(6)	6.289(6)	−0.267(5)
C_{16}	3.803(1)	4.158(2)	7.961(1)	−0.355(1)
D_4	5.049(2)	4.783(4)	9.831(2)	0.266(2)
C_{17}	14.035(3)	13.676(2)	27.711(1)	0.359(1)
C_{18}	13.670(2)	13.863(3)	27.533(3)	−0.194(2)
C_{19}	11.758(4)	13.924(4)	25.682(4)	−2.166(4)
C_{20}	14.007(1)	12.006(1)	26.013(2)	2.001(3)

Note: The data were calculated in our study. Source: own study.

4.2. Results of the Second-Stage Analysis Using DANP

We then constructed the INRMs based on the results in Table 4–8. Figure 2 depicts the INRM for the four dimensions (financial performance, bond financing, ESG factors, and COVID-19). Financial performance (D_1) had the strongest influence (10.835), followed by COVID-19 (D_4, 9.831), ESG factors (D_3, 9.660), and bond issuance (D_2, 9.368). In addition, financial performance (D_1, 0.545) and COVID-19 (D_4, 0.266) were the causes, and ESG factors (D_3, −0.030) and bond financing (D_2, −0.781) were the effects.

The empirical results indicated that:

H1 that financial performance is a significant factor affecting global shipping companies is validated;

H2 that ESG is a significant factor affecting global shipping companies is not validated;

H3 that bond financing is a significant factor affecting global shipping companies is not validated;

H4 that COVID-19 is a significant factor affecting global shipping companies is validated.

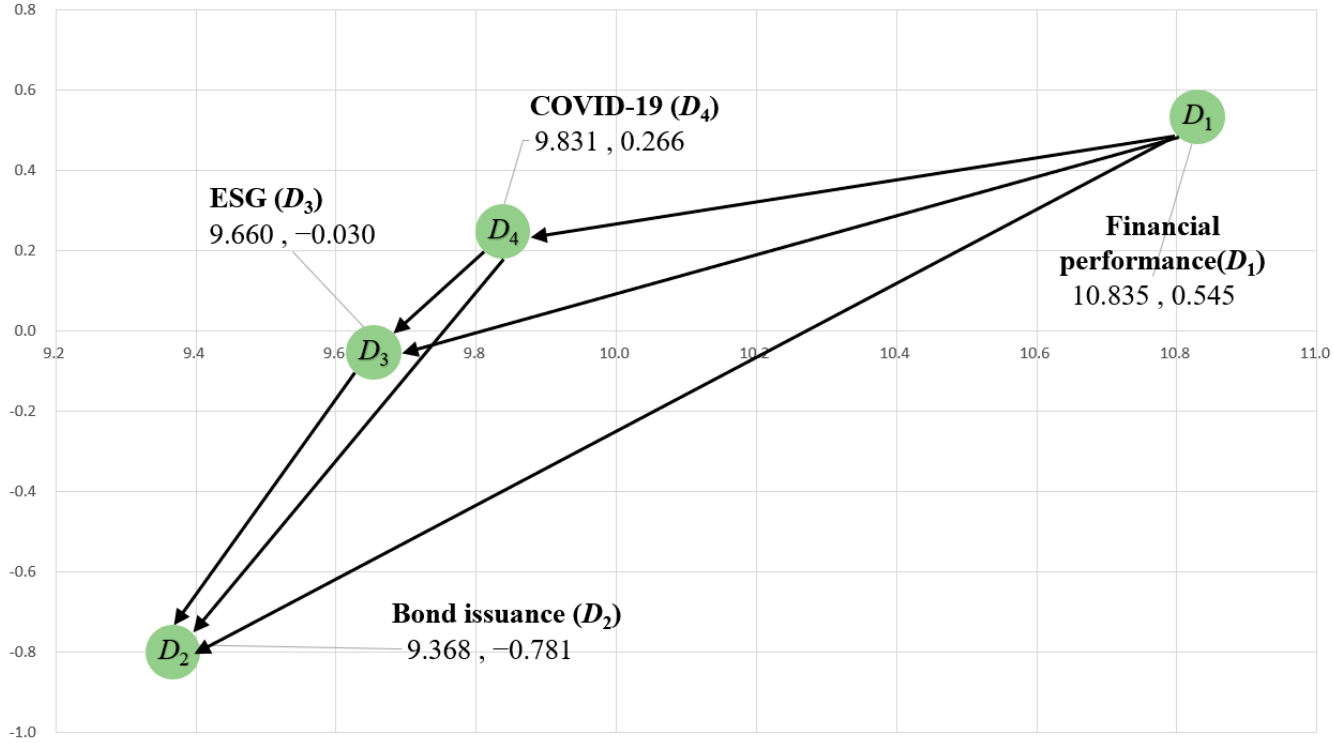
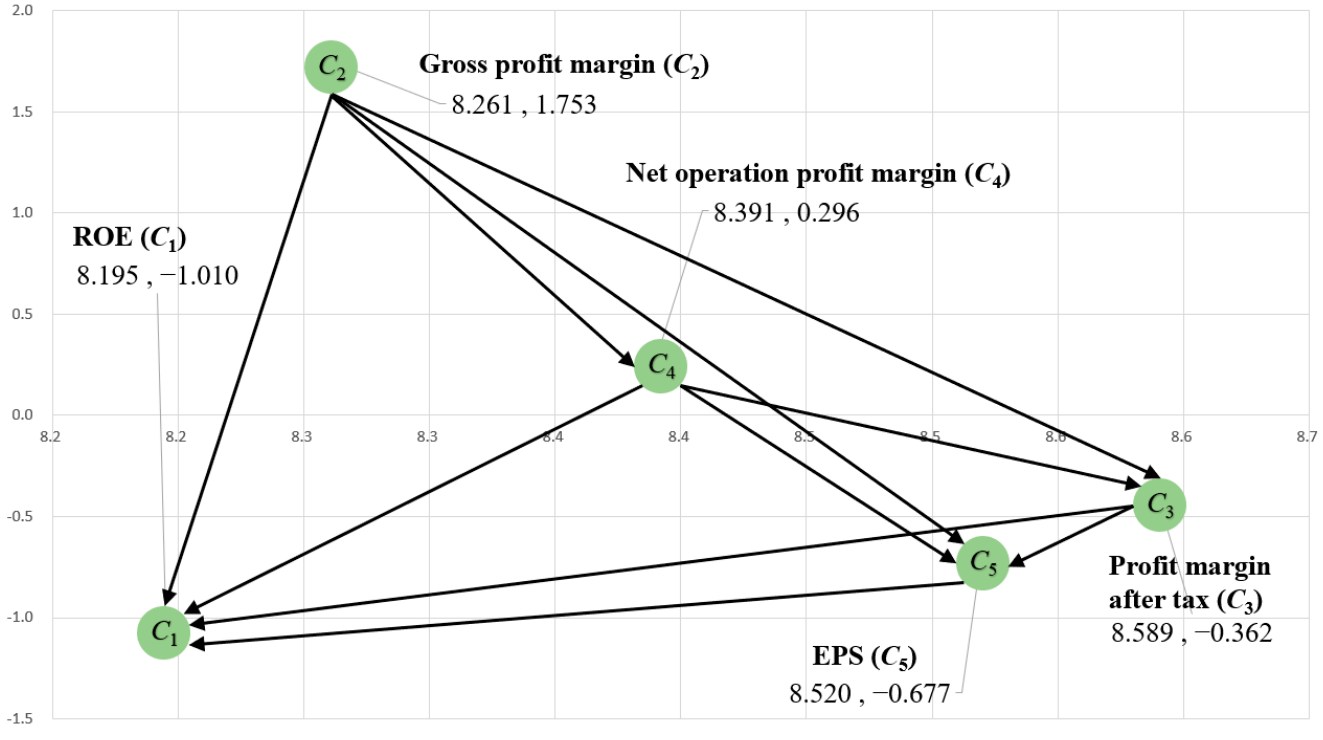


Figure 2. INRM of the four dimensions D_1–D_4.

The INRM for the five criteria (C_1–C_5) under the dimension of financial performance (D_1) is illustrated in Figure 3. Profit margin after tax (C_3, 8.589) had the greatest influence, followed by EPS factors (C_5, 8.520), net operating profit margin (C_4, 8.391), gross profit margin (C_2, 8.261), and ROE (C_1, 8.195). Furthermore, gross profit margin (C_2, 1.753) and net operating profit margin (C_4, 0.296) were the causes, and profit margin after tax (C_3, −0.362), EPS factors (C_5, −0.677), and ROE (C_1, −1.010) were the effects.



2

Figure 3. INRM of criteria C_1–C_5 in the dimension of financial performance (D_1).

The INRM of the four criteria (C_6–C_9) in the dimension of bond financing (D_2) is presented in Figure 4. Yield to maturity (C_7, 16.403) exerted the most influence, followed by term to maturity (C_6, 15.721), bond market value (C_9, 15.453), and, finally, credit rating (C_8, 15.631). Additionally, term to maturity (C_6, 1.238) and yield to maturity (C_7, 0.604) were the causes, and bond market value (C_9, −0.158) and credit rating (C_8, −1.684) were the effects.

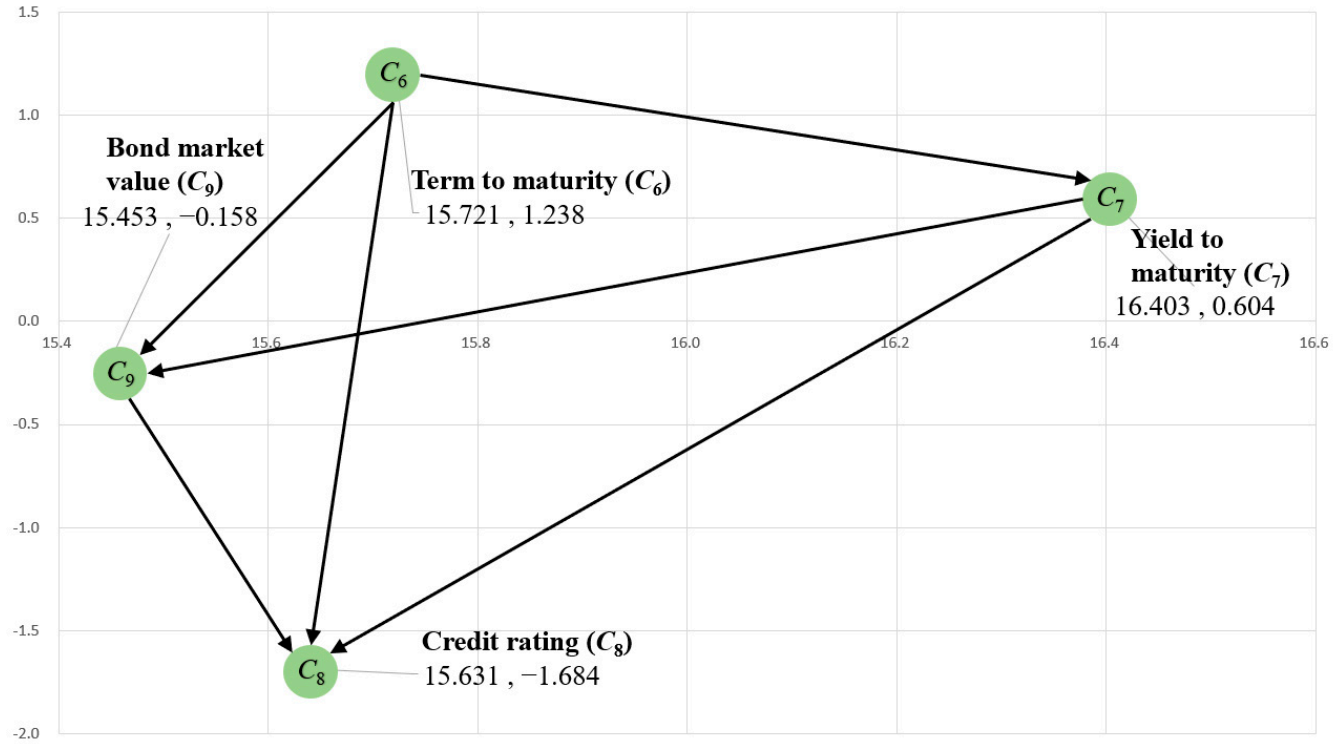


Figure 4. INRM of the four criteria (C_6–C_9) in the dimension of bond financing (D_2).

The INRM for the seven criteria (C_{10}–C_{16}) in the dimension of ESG (D_3) is illustrated in Figure 5. CSR (C_{16}, 7.961) had the strongest influence, followed by board size (C_{12}, 6.420), proportion of independent directors (C_{11}, 6.395), air pollution (C_{13}, 6.424), reduction in CO_2 emissions (C_{14}, 6.401), ownership by internal parties (C_{10}, 6.268), and employee education and training (C_{15}, 6.289). Moreover, air pollution (C_{13}, 0.072), reduction in CO_2 emissions (C_{14}, 0.115), board size (C_{12}, 0.355), and proportion of independent directors (C_{11}, 0.086) were the causes. Ownership by internal parties (C_{10}, −0.005), employee education and training (C_{15}, −0.267), and CSR (C_{16}, −0.355) were the effects.

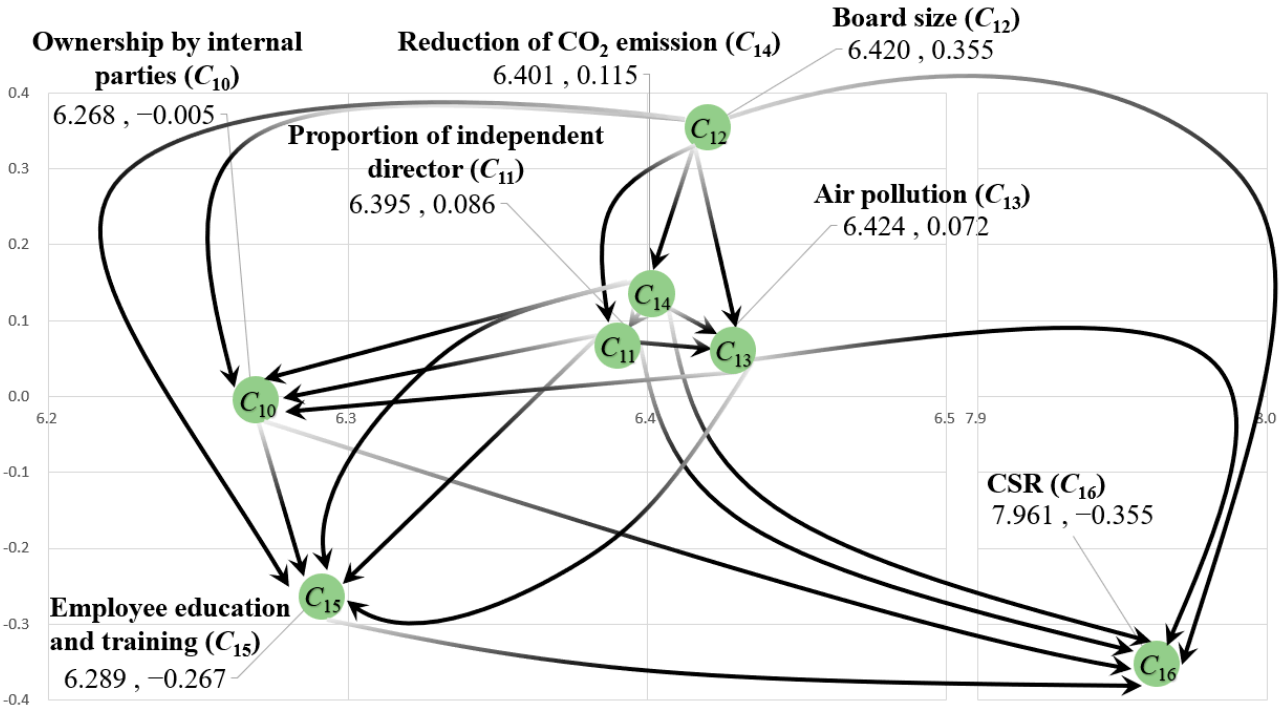


Figure 5. INRM of the seven criteria (C_{10}–C_{16}) in the dimension of ESG factors (D_3).

The INRM of the four criteria (C_{17}–C_{20}) in the dimension of COVID-19 (D_4) is depicted in Figure 6. We uncovered that the criteria of emergency response plan (C_{17}, 27.711) had the highest influence, followed by employee safety (C_{18}, 27.533), social distancing (C_{20}, 26.013), and timely delivery (C_{19}, 25.682). Furthermore, social distancing (C_{20}, 2.001) and emergency response plan (C_{17}, 0.359) were the causes, and employee safety (C_{18}, −0.194) and timely delivery (C_{19}, −2.166) were the effects.

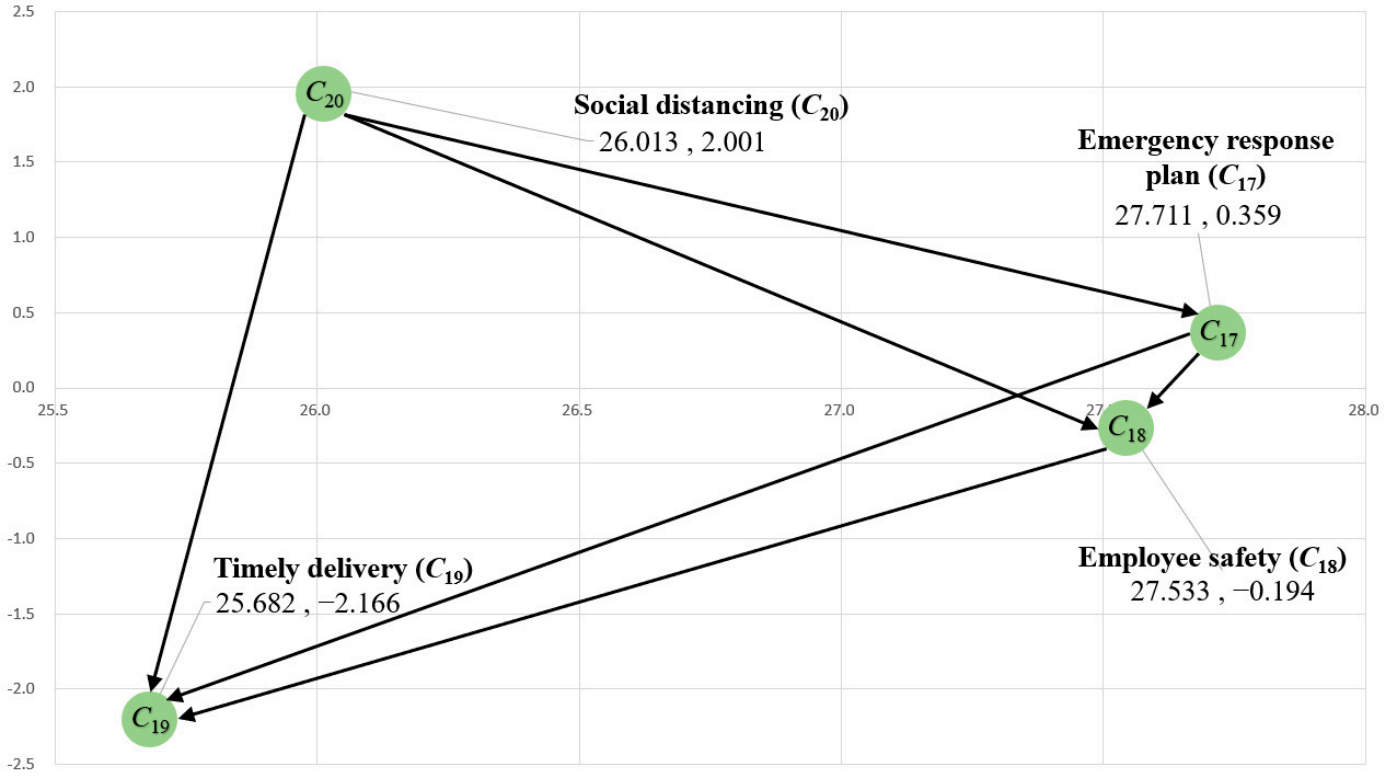


Figure 6. INRM of the four criteria (C_{17}–C_{20}) in the dimension of COVID-19 (D_4).

Table 10 presents the ranking of the 4 dimensions and 20 criteria in terms of the degree of their total influence (centrality) and their cause or effect status.

Table 10. Ranking of the 4 dimensions and 20 criteria.

Dimension/Criteria	q + c Ranking of Centrality	Cause or Effect
Financial performance (D_1)	1	Cause
ROE (C_1)	5	Effect
Gross Profit Margin (C_2)	4	Cause
Profit Margin After Tax (C_3)	1	Effect
Net Operating Profit Margin (C_4)	3	Cause
EPS (C_5)	2	Effect
Bond financing (D_2)	4	Effect
Term to Maturity (C_6)	2	Cause
Yield to maturity (C_7)	1	Cause
Credit rating (C_8)	4	Effect
Bond market value (C_9)	3	Effect
ESG (D_3)	3	Effect
Ownership by internal parties (C_{10})	3	Effect
Proportion of independent director (C_{11})	2	Cause
Board size (C_{12})	7	Cause
Air pollution (C_{13})	4	Cause
Reduction of CO2 emission (C_{14})	5	Cause
Employee education and training (C_{15})	6	Effect
CSR (C_{16})	1	Effect
COVID-19 (D_4)	2	Cause
Emergency responses plan (C_{17})	1	Cause
Employee safety (C_{18})	3	Effect

Timely delivery (C_{19})	4	Effect
Social distancing (C_{20})	2	Cause

Source: own study.

4.3. Results of the Third-Stage Analysis Using the Modified VIKOR Method

We applied the modified VIKOR method to the weights derived from the second-stage analysis to compute the gap between the actual level and aspiration level of the 9 shipping companies based on the 4 dimensions and 20 criteria. The results are summarized in Table 11.

Table 11. Gaps between the actual level and aspiration level of the shipping companies.

Gap	Shipping Co. A	Shipping Co. B	Shipping Co. C	Shipping Co. D	Shipping Co. E	Shipping Co. F	Shipping Co. G	Shipping Co. H	Shipping Co. I
Financial performance (D_1)	0.088	0.116	0.129	0.135	0.169	0.147	0.123	0.112	0.132
ROE (C_1)	0.008	0.009	0.010	0.009	0.029	0.014	0.008	0.005	0.007
Gross Profit Margin (C_2)	0.015	0.022	0.025	0.030	0.034	0.033	0.026	0.022	0.033
Profit Margin After Tax (C_3)	0.024	0.029	0.028	0.028	0.029	0.028	0.028	0.028	0.027
Net Operating Profit Margin (C_4)	0.014	0.015	0.025	0.027	0.035	0.032	0.021	0.017	0.024
EPS (C_5)	0.027	0.041	0.041	0.041	0.042	0.041	0.041	0.040	0.041
Bond financing (D_2)	0.141	0.143	0.151	0.191	0.161	0.201	0.195	0.175	0.152
Term to Maturity (C_6)	0.029	0.034	0.036	0.042	0.032	0.047	0.041	0.052	0.050
Yield to maturity (C_7)	0.060	0.060	0.059	0.061	0.060	0.061	0.061	0.044	0.058
Credit rating (C_8)	0.028	0.014	0.035	0.028	0.007	0.038	0.035	0.038	0.007
Bond market value (C_9)	0.024	0.035	0.021	0.060	0.062	0.055	0.058	0.041	0.037
ESG (D_3)	0.188	0.165	0.169	0.179	0.187	0.172	0.181	0.195	0.178
Ownership by internal parties (C_{10})	0.016	0.015	0.003	0.019	0.019	0.020	0.016	0.032	0.012
Proportion of independent director (C_{11})	0.022	0.000	0.005	0.000	0.010	0.000	0.000	0.000	0.013
Board size (C_{12})	0.017	0.015	0.026	0.026	0.024	0.017	0.029	0.028	0.017
Air pollution (C_{13})	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Reduction of CO_2 emission (C_{14})	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Employee education and training (C_{15})	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032

CSR disclosure (C_{16})	0.040	0.041	0.040	0.040	0.040	0.041	0.041	0.041	0.041
COVID-19 (D_4)	0.223	0.224	0.223	0.224	0.223	0.224	0.225	0.224	0.225
Emergency responses plan (C_{17})	0.057	0.057	0.057	0.057	0.057	0.058	0.058	0.058	0.058
Employee safety (C_{18})	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Timely delivery (C_{19})	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Social distancing (C_{20})	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.051	0.050
Total Gap ($0.5\times S_k+0.5\times Q_k$)	**0.350**	**0.354**	**0.365**	**0.395**	**0.401**	**0.402**	**0.392**	**0.383**	**0.373**
Rank	**1**	**2**	**3**	**7**	**8**	**9**	**6**	**5**	**4**

Source: own study.

The information in Table 11 can be read vertically to identify the largest gaps from the aspiration level for each shipping company; the dimension criteria with the largest gaps are the worst-performing factors. For example, the dimension with the largest gap for Shipping Company A was COVID-19 (0.223), followed by ESG factors (0.188), bond financing (0.141), and financial performance (0.088). In terms of financial performance criteria, for Shipping Company A, the largest gap was in EPS factors (0.027), followed by profit margin after tax (0.024), gross profit margin (0.015), net operating profit margin (0.014), and ROE (0.008). With regard to bond financing, for Shipping Company A, the largest gap was in yield to maturity (0.060), term to maturity (0.029), credit rating (0.028), and bond market value (0.024). Regarding ESG factors, for Shipping Company A, the largest gap was in CSR (0.04), followed by employee education and training (0.032), air pollution (0.031), reduction in CO_2 emissions (0.031), proportion of independent directors (0.022), board size (0.017), and ownership by internal parties (0.016). In terms of COVID-19, for Shipping Company A, the largest gap was in timely delivery and employee safety (both 0.058), followed by emergency response plan (0.057) and social distancing (0.050).

Table 11 can also be examined horizontally to identify the largest and smallest gaps across shipping companies. The shipping companies with the smallest and largest gaps exhibited the most favorable and unfavorable performance, respectively. For the financial performance dimension (D_1), Shipping Company A (0.088) and E (0.169) had the smallest and largest gaps, respectively, and they outperformed and were outperformed by the other shipping companies, respectively. For the bond financing dimension (D_2), Shipping Company A and F had the smallest (0.141) and largest (0.201) gaps, respectively. For the dimension of ESG factors (D_3), Shipping Company B and H had the smallest (0.165) and largest (0.195) overall gap, respectively. For the COVID-19 dimension (D_4), Shipping Company A, C, and E (0.223) had the smallest gap, whereas Shipping Company G and I (0.225) had the largest overall gap.

Furthermore, we ranked the nine shipping companies based on their overall gap between the actual level and aspiration level listed in Table 11. The top-ranked companies were Shipping Company A, B, and C. Shipping Company A, for example, ranked number 1 with the smallest gaps in financial performance (D_1) and bond financing (D_2). Shipping Company B ranked number 2 with the smallest gap in ESG factors (D_3) and the second-smallest gaps in bond financing (D_2) and COVID-19 (D_4). Finally, Shipping Company C ranked number 3 with the smallest gap in COVID-19 (D_4) and the second-smallest gap in ESG factors (D_3).

4.4. Discussion

Based on the results of this study, financial performance (D_1) is the most influential dimension, followed by COVID 19 (D_4), ESG factors (D_3), and bond financing (D_2). The primacy of financial performance is consistent with findings in the literature that investors mainly consider the profitability of a given set of stocks and their attractiveness as a means of diversifying their investment portfolios [8,28]. This phenomenon remains true despite the occurrence of COVID 19 and the increasing importance of ESG regulations. The results signify that those investors should continue to focus on financial performance when seeking shipping company stocks to invest in because the empirical evidence demonstrates that shipping companies with better financial performance led to higher achievements in three other areas of sustainability.

COVID-19 is the second most influential dimension because of its effect on the ability of shipping companies to manage emergencies, such as labor shortages and delays in delivery. Shipping companies must deal with the problems arising from COVID-19 and implement proper disinfection and social distancing measures to safeguard employees' health. This finding corresponds to the literature stating that shipping companies reacting to COVID-19 more rapidly and managing emergencies more effectively than their counterparts are more likely to succeed during the pandemic [58,69–71].

ESG factors (D_3) ranked third with a distinctly lower priority, probably because they are more important to regulators and other stakeholders (banks and customers) than to equity and bond investors. This finding contradicts the extant literature that ESG activities are highly valued by investors [72–74]. The empirical evidence of this study demonstrated that ESG initiatives are not as critical to investors as firms' profitability and their abilities to combat the negative effects of the COVID-19 pandemic.

Bond financing (D_2) is the least influential dimension, which may be attributable to two reasons. First, investors prefer equity to bonds because they anticipate returns on investments from capital gain and dividends rather than from interests on bonds [8,19]. Second, these large shipping companies were few and able to issue bonds because they received similar credit ratings and yield to maturity, hence the similar risk level. Therefore, investors are concerned less with the bond default risk of shipping companies when selecting stocks [3,23].

The above results show that financial performance affects COVID-19 and ESG practices, which suggests that shipping companies with higher financial performance are more capable of coping with the negative effects of COVID-19. In addition, COVID-19 affects ESG factors and bond financing, indicating that COVID-19 tends to force the shipping companies to comply with ESG regulations and increase bond financing. Moreover, ESG factors influence bond financing, which implies that shipping companies with more ESG activities can attract more bond investors.

With the dimension of financial performance, gross profit margin is the main cause, which affects net profit margin, EPS, and ROE. Such a result contradicts the literature claiming ROE is the most important indicator [25,38]. However, EPS posed the largest gap between the actual level and aspirational level across all shipping companies, indicating that the shipping companies underperformed in achieving acceptable EPS. This outcome suggests that shipping companies could improve EPS by enlarging the gross profit margin. That is, shipping companies should focus on their revenue and variable costs rather than fixed costs to increase EPS.

Within the dimension of bond financing, term to maturity is the main cause, which affects yield to maturity, bond market value, and finally, credit rating. However, yield to maturity exhibited the largest gap between the actual and aspirational levels across nine shipping companies. Such a result is consistent with prior research revealing that investors demand a higher rate of return for bearing additional risk inherent in the shipping industry [40]. The outcome of this study suggests that shipping companies should structure appropriate term to maturity to raise the yield to maturity, thus increasing bond financing.

With the dimension of ESG, board size influences reduction in CO2, air pollution, proportion of independent directors, and finally, CSR. Such finding corresponds to the literature stating higher board diversity led to better corporate governance [4,11]. However, CSR caused the largest gap between the actual and aspiration levels, which implies that shipping companies paid less attention to seafarers' health. It can be inferred that shipping companies typically focus on their business operations rather than effective communication with investors through disclosure on their annual reports. The result of this study indicates shipping companies may narrow the gap in the CSR areas by enlarging board size and diversity.

Within the dimension of COVID-19, social distancing is the main cause affecting emergency response plan, employee safety, and finally, timely delivery. However, employee safety and timely delivery equally posed the largest gap for improvement to reach the aspiration level. This outcome is somewhat inconsistent with a prior study claiming that delivery delays and labor shortages were the main causes for the disruption of business sustainability and that developing an emergency response plan was most important from ground to sea operations during the COVID-19 period [58]. On the contrary, the results of this study suggest that when faced with COVID-19 and other similar emergencies, shipping companies must first enforce internal policies such as social distancing to ensure employees' safety and health, achieving timely delivery to customers' sites.

Furthermore, we ranked the nine shipping companies based on the overall performance gap between the actual and aspirational levels drawn from four dimensions. Although investors may diversify their investment portfolios by including shipping company stocks, investors must realize which firms are better able to achieve sustainability and cope with the challenges amid COVID-19. Shipping Company A fell in the first place regarding financial performance, bond financing, and COVD-19 response, whereas Shipping Company B caught first place in ESG and second place in bond financing and COVID-19. Finally, Shipping Company C had fallen in third place in bond financing, ESG, and second place in COVID-19. Based on the overall results, we recommend investors consider Shipping Company A, B, and C when selecting stocks.

5. Conclusions

The global shipping industry represents the largest provider of transportation in the world. Thus, the stocks of shipping companies allow investors to diversify their investment portfolios. However, the global shipping companies face the issue of sustainability from multiple perspectives. The literature mostly examined the shipping companies through financial performance and freight rates while neglecting the increasing importance of the qualitative factors such as social welfare, environmental impact, and corporate governance. Moreover, during the 2020–2021 COVID-19 pandemic, the global shipping companies faced unprecedented challenges such as seafarers' infections and delivery delays. A research gap, therefore, existed as prior studies rarely analyzed the global shipping companies from qualitative factors in addition to quantitative ones involving financial performance, thus unable to provide a holistic view regarding the sustainable attainment of the global shipping companies.

The purpose of this study is to identify the key factors affecting the sustainability of the global shipping companies from four dimensions and twenty criteria using a hybrid MCDM method named DANP-mV. The four dimensions include financial performance that determines business sustainability, bond financing that provides long-term funds, ESG regulations that strengthen corporate governance, social and environmental enhancement, and COVID-19 caused port congestions and delays in shipments. We analyzed survey responses from fifteen investment experts and the data of nine international shipping companies from 2010 to 2020. The novice DANP-mV model determined the causal relationships among the four dimensions and twenty criteria, suggesting ways in which each shipping company can narrow its performance gap between the actual and inspiration levels in each dimension.

The empirical results of this study validated H1 and H4. Specifically, H1 financial performance is the most significant dimension, followed by H4 COVID-19. The dimension of financial performance directly influences the dimension of COVID-19. Financial performance and COVID-19 influence ESG, which in turn affects bond financing. These findings are consistent with the extant literature that financial indicators are mostly scrutinized by equity and bond investors and that shipping companies need to respond to emergencies rapidly [19,21]. Although ESG has gained increasing importance in the literature, it is regarded as less crucial compared to financial performance and emergencies such as the COVID-19 [18,36,50]. The outcome of this study suggests that shipping companies with higher financial performance can better cope with the negative effects of COVID-19. Therefore, investors can reasonably assume that shipping companies with better financial performance are more likely to succeed during the COVID-19 pandemic. The higher financial performance also helps shipping companies implement ESG practices. Similarly, by increasing ESG activities, shipping companies are likely to attract more investors to favor their bonds, which provides a long-term and stable source of funds. Thus, investors may presume that shipping companies with more ESG compliance are capable of raising more funds through bond issuance in the long run.

Within the dimension of financial performance, gross profit margin is the main cause rather than the commonly mentioned ROE in the literature [18–20]. Gross profit margin affects operating profit margin, EPS, and finally, ROE. This result is consistent with Markowitz [30] and Sroufe and Goalakrishna-Remani [36] that profitability is the key to measuring firm performance. The largest performance gap across all shipping companies is EPS. The results of this study further highlight that by improving gross profit margin, shipping companies can improve EPS.

Within the dimension of bond financing, term to maturity is the main cause affecting yield to maturity, bond market value, and credit rating. This result is contrary to the literature that credit rating plays the most important role [22,23] and consistent with prior researchers who claimed high yield-to-maturity entails higher returns for investors [41]. The result of this study suggests that by setting an appropriate term to maturity, shipping companies may increase yield to maturity, which poses the largest gap between the actual and aspirational levels across all shipping companies.

Within the dimension of ESG, board size is the main cause affecting the environmental factors, such as a reduction in CO2 and air pollution, as well as governance factors such as the proportion of independent directors. Subsequently, the environmental and social factors affect the social factors such as employee safety and training. Such results correspond to Alexandridis et al. [19], who claimed that corporate governance offers the legal and institutional mechanism that aligns the interests of managers and shareholders. On the contrary, CSR leads to the largest performance gap across all shipping companies. Thus, the outcome of this study indicates shipping companies may narrow their performance gap in CSR by enlarging the board size and diversity.

Within the dimension of COVID-19, social distancing is the main cause affecting emergency response plan, employee safety, and timely delivery. Such findings are inconsistent with the literature that an emergency response plan is most important to fight the COVID-19 pandemic [58]. On the other hand, employee safety and timely delivery represent the largest performance gap across all shipping companies. The result of this study suggests that shipping companies must first strictly enforce social distancing policy in an aim to achieve employee safety and timely delivery, preventing disruptions of shipping business sustainability during the COVID-19 period.

Because the sample of nine shipping companies accounted for 49% of the global market share in terms of market capitalization, the results of this study can be generalized. Three broad implications drawn from the findings of this study can be applied to the global shipping industry. First, the global shipping companies may focus on financial performance, particularly gross profit margin, to better cope with adverse events, such as the COVID-19 pandemic. Second, shipping companies that implement the ESG practices may

attract more bond investors, thus increasing bond financing. Third, equity investors should continue to focus on the financial performance of the shipping companies when selecting stocks because these shipping companies tend to outperform their rivals in the areas of sustainability, such as ESG and financing.

Moreover, we ranked the nine companies based on the overall performance gap in the four dimensions. The shipping companies that had smaller gaps between their actual level and aspiration level outperformed those with larger gaps between these levels. Thus, this analysis identifies the global shipping companies that are most likely to attain sustainability and worth investing in. We recommend Shipping Company A, B, and C to investors. In addition, investors are advised to focus on the financial performance and on proactive and reactive measures executed by shipping companies in response to COVID-19 when selecting shipping stocks.

This study was limited primarily by the timing of the distribution of the survey questionnaires. The experts received the surveys in 2020, slightly more than 1 year after the first COVID-19 outbreak. If the survey participants had received the surveys at a later time, they could have provided greater insight into the effect of the COVID-19 pandemic. Hence, future research could examine the strategies formulated by shipping companies in response to the COVID-19 crisis. Moreover, researchers could compare the practices of shipping companies before, during, and after COVID-19.

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References

1. United Nation Conference on Trade and Development UNCTAD. *Review of Maritime Transport 2019*; United Nation Conference on Trade and Development UNCTAD: Geneva, Switzerland, 2019. Available online: Unctad.org>en>PublicationsLibrary (accessed on 28 August 2021).
2. World Trade Organization. International Trade Statistics 2020. Available online: https://www.wto.org/english/res_e/statis_e/wts2020_e/wts20_toc_e.htm (accessed on 27 August 2021).
3. Grelck, M.B.; Prigge, S.; Tegtmeier, L.; Topalov, M. Diversification properties of investments in shipping. *J. Altern. Invest.* **2009**, *12*, 55–74. https://doi.org/10.3905/JAI.2009.12.1.055.
4. Di Vaio, A.; Varriale, L.; Lekakou, M.; Stefanidaki, E. Cruise and container shipping companies: A comparative analysis of sustainable development goals through environmental sustainability disclosure. *Marit. Policy Manag.* **2021**, *48*, 184–212. https://doi.org/10.1080/03088839.2020.1754480.
5. Fasoulis, I.; Kurt, R.E. Embracing sustainability in shipping: Assessing Industry's adaptations incited by the, newly, introduced 'triple bottom line' approach to sustainable maritime development. *Soc. Sci.* **2019**, *8*, 208. https://doi.org/10.3390/socsci8070208.
6. Lee, P.; Kwon, O.; Ruan, X. Sustainability challenges in maritime transport and logistics industry and its way ahead. *Sustainability* **2019**, *11*, 1331. https://doi.org/10.3390/su11051331.
7. Wu, X.; Zhang, L.; Feng, H. Green strategic planning approach for international shipping activities. *Sustainability* **2020**, *12*, 41. https://doi.org/10.3390/su12010041.
8. Albertijn, S.; Bessler, W.; Drobetz, W. Financing shipping companies and shipping operations: A Risk-Management perspective. *J. Appl. Corp. Finance* **2011**, 70–82.
9. Giannakopoulou, E.N.; Thalassinos, E.I.; Stamatopoulos, T.V. Corporate governance in shipping: An overview. *Marit. Policy Manag.* **2016**, *43*, 19–38. https://doi.org/10.1080/03088839.2015.1009185.
10. Lirn, T.; Lin, H.; Shang, K. Green shipping management capability and firm performance in the container shipping industry. *Marit. Policy Manag.* **2014**, *41*, 159–175. https://doi.org/10.1080/03088839.2013.819132.
11. Alexandridis, G.; Kavussanos, M.G.; Kim, C.Y.; Tsouknidis, D.A.; Visvikis, I.D. A survey of shipping finance research: Setting

the future research agenda. *Transport. Res. Part. E-Log.* **2018**, *115*, 164–212. https://doi.org/10.1016/j.tre.2018.04.001
12. Thai, V.; Jie, F. The impact of total quality management and supply chain integration on firm performance of container shipping companies in Singapore. *Asia Pacific J. Mark. Logist.* **2018**, *30*, 605–626. https://doi.org/10.1108/APJML-09-2017-0202.
13. Lu, C.; Lin, C.; Tu, C. Corporate social responsibility and organisational performance in container shipping. *Int. J. Bus. Logist.* **2009**, *12*, 119–132. https://doi.org/10.1080/13675560902749373.
14. Tamayo-Torres, I.; Gutierrez-Gutierrez, L.; Ruiz-Moreno, A. Boosting sustainability and financial performance: The role of supply chain controversies. *Int. J. Prod. Res.* **2019**, *57*, 3719–3734. https://doi.org/10.1080/00207543.2018.1562248.
15. Shin, Y.; Thai, V.V. The impact of corporate social responsibility on customer satisfaction, relationship maintenance and loyalty in the shipping industry. *Corp. Soc. Responsib. Environ. Manag.* **2015**, *22*, 381–392. https://doi.org/10.1002/csr.1352.
16. Tang, L.; Gekara, V. The importance of customer expectations: An analysis of CSR in container shipping. *J. Bus. Ethics* **2020**, *165*, 383–393. https://doi.org/10.1007/s10551-018-4062-4.
17. United Nations. Principles for Responsible Investment. Available online: https://www.unpri.org/sustainability-issues (accessed on 27 August 2021).
18. United Nations. The 17 Goals of Sustainable Development. Available online: https://sdgs.un.org/goals (accessed on 28 August 2021).
19. Kotsantonis, S.; Pinney, C.; Serafeim, G. ESG integration in investment management: Myths and realities. *J. Appl. Corp. Finance* **2016**, *28*, 10–16. https://doi.org/10.1111/jacf.12169
20. Siminica, M.; Cristea, M.; Sichigea, M.; Noja, G.G.; Anghel, I. Well-governed sustainability and financial performance: A new integrative approach. *Sustainability* **2019**, *11*, 4562. https://doi.org/10.3390/su11174562.
21. Haider, J.; Ou, Z.; Pettit, S. Predicting corporate failure for listed shipping companies. *Marit. Econ. Logist.* **2019**, *21*, 415–438. https://doi.org/10.1057/s41278-018-0101-4.
22. Kavussanos, M.G.; Tsouknidis, D.A. The determinants of credit spreads changes in global shipping bonds. *Transport. Res. Part. E-Log.* **2014**, *70*, 55–75. https://doi.org/10.1016/j.tre.2014.06.001
23. 23Grammenos, C.T.; Alizadeh, A.H.; Papapostolou, N.C. Factors affecting the dynamics of yield premia on shipping seasoned high yield bonds. *Transport. Res. Part. E-Log.* **2007**, *43*, 549–564. https://doi.org/10.1016/j.tre.2006.07.002.
24. Sroufe, R.; Gopalakrishna-Remani, V. Management, social sustainability, reputation, and financial performance relationships: An empirical examination of U.S. firms. *Organ. Environ.* **2019,** *32*, 331–362. https://doi.org/10.1177/1086026618756611.
25. Tsionas, M.G.; Merikas, A.G.; Merika, A.A. Concentrated ownership and corporate performance revisited: The case of shipping. *Transport. Res. Part. E-Log.* **2012**, *48*, 843–852. https://doi.org/10.1016/j.tre.2012.01.004.
26. Fotteler, M.L.; Andrioti Bygvraa, D.; Jensen, O.C. The impact of the maritime labor convention on seafarers' working and living conditions: An analysis of port state control statistics. *BMC Public Health* **2020**, *20*, 1586–1586. https://doi.org/10.1186/s12889-020-09682-6.
27. Jensen, M.C.; Meckling, W.H. Theory of the firm: Managerial behavior, agency costs and ownership structure. *J. Financ. Econ.* **1976**, *3*, 305–360. https://doi.org/10.1016/0304-405X(76)90026-X.
28. Okoli, C.; Pawlowski, S.D. The Delphi method as a research tool: An example, design considerations and applications. *Inf. Manag.* **2004**, *42*, 15–29. https://doi.org/10.1016/j.im.2003.11.002.
29. Liou, J.; Tzeng, G.H. Comments on "Multiple criteria decision making (MCDM) methods in economics: An overview". *Technol. Econ. Dev. Econ.* **2012**, *18*, 672–695. https://doi.org/10.3846/20294913.2012.753489.
30. Markowitz, H.M. Foundations of portfolio theory. *J. Finance* **1991**, *46*, 469–477. https://doi.org/10.1111/j.1540-6261.1991.tb02669.x.
31. Otheitis, N.; Kunc, M. Performance measurement adoption and business performance: An exploratory study in the shipping industry. *Manag. Decis.* **2015**, *53*, 139–159. https://doi.org/10.1108/MD-02-2014-0108.
32. Hsieh, H.P.; Kuo, K.; Le, M.; Lu, W. Exploring the cargo and eco-efficiencies of international container shipping companies: A network-based ranking approach. *Manage. Decis Econ.* **2021**, *42*, 45–60. https://doi.org/10.1002/mde.3212.
33. McKinsey & Company. Container Shipping: The Next 50 Years by USA. Available online: https://www.freightwaves.com/news/2017/10/26/mckinsey-forecasts-the-next-50-years-of-container-shipping (accessed 26 August 2021).
34. Syriopoulos, T.; Bakos, G. Investor herding behaviour in globally listed shipping stocks. *Marit. Policy Manag.* **2019**, *46*, 545–564. https://doi.org/10.1080/03088839.2019.1597288.
35. Theodossiou, P.; Tsouknidis, D.; Savva, C. Freight rates in downside and upside markets: Pricing of own and spillover risks from other shipping segments. *J. R Stat. Soc. Ser. Stat. Soc.* **2020**, *183*, 1097–1119. https://doi.org/10.1111/rssa.12553.
36. Panayides, P.M. *The Routledge Handbook of Maritime Management*, 1st ed.; Routledge: London, UK, 2019. https://doi.org/10.4324/9781315617138.
37. Syriopoulos, T.C. Financing Greek shipping: Modern instruments, methods and markets. *Res. Transp. Econ.* **2007**, *21*, 171–219.
38. Kang, H.; Wang, G.W.Y.; Bang, H.; Woo, S. Economic performance and corporate financial management of shipping firms. *Marit. Econ. Logist.* **2016**, *18*, 317. https://doi.org/10.1057/mel.2015.8.
39. Woo, S.; Lai, P.; Chen, Y.; Yang, C. Meta-frontier function approach to operational efficiency for shipping companies. *Marit. Policy Manag.* **2019**, *46*, 529–544. https://doi.org/10.1080/03088839.2019.1594424.
40. Kavussanos, M.G.; Visvikis, I.D.; Alexopoulos, I. Managing financial resources in shipping. In *Shipping Operations Management*; Visvikis, I.D., Panayides, P.M., Eds.; Springer: Cham, Switzerland, 2017, pp. 153–175. https://doi.org/10.1007/978-3-319-62365-8_7
41. Grammenos, C.T.; Arkoulis, A.G. Determinants of spreads on new high yield bonds of shipping companies. *Transport. Res. Part.*

E-Log. **2003**, *39*, 459–471. https://doi.org/10.1016/S1366-5545(03)00054-1.
42. Freeman, R.E. *Strategic Management: A Stakeholder Approach*; Pitman: Boston, MA, USA, 1984.
43. Wu, X.; Zhang, L.; Luo, M. Discerning sustainability approaches in shipping. *Environ. Dev. Sustain.* **2020**, *22*, 5169–5184. https://doi.org/10.1007/s10668-019-00419-z.
44. Vejvar, M.; Lai, K.; Lo, C.K.Y. A citation network analysis of sustainability development in liner shipping management: A review of the literature and policy implications. *Marit. Policy Manag.* **2020**, *47*, 1–26. https://doi.org/10.1080/03088839.2019.1657971.
45. Ducruet, C. Multilayer dynamics of complex spatial networks: The case of global maritime flows (1977–2008). *J. Transp. Geogr.* **2017**, *60*, 47–58. https://doi.org/10.1016/j.jtrangeo.2017.02.007
46. Mohagheghi, V.; Mousavi, S.M.; Aghamohagheghi, M.; Vahdani, B. A new approach of multi-criteria analysis for the evaluation and selection of sustainable transport investment projects under uncertainty: A case study. *Int. J. Comput. Intell. Syst.* **2017**, *10*, 605. https://doi.org/10.2991/ijcis.2017.10.1.41.
47. Narula, K. Emerging trends in the shipping industry—Transitioning towards sustainability. *Marit. Aff.* **2014**, *10*, 113–138. https://doi.org/10.1080/09733159.2014.928473.
48. Dahalan, W.A.; Zainol, Z.A.; Yaa'kub, N.I.; Kassim, N.M. Corporate social responsibility (csr) from shipping companies in the straits of malacca and singapore. *Int. J. Bus. Soc.* **2012**, *13*, 197.
49. Yuen, K.F.; Thai, V.V.; Wong, Y.D. Corporate social responsibility and classical competitive strategies of maritime transport firms: A contingency-fit perspective. *Transp. Res. A Policy Pract.* **2017**, *98*, 1–13. doi.org/10.1016/j.tra.2017.01.020.
50. Syriopoulos, T.; Tsatsaronis, M. The corporate governance model of the shipping firms: Financial performance implications. *Marit. Policy Manag.* **2011**, *38*, 585–604. https://doi.org/10.1080/03088839.2011.615867.
51. Andreou, P.C.; Louca, C.; Panayides, P.M. Corporate governance, financial management decisions and firm performance: Evidence from the maritime industry. *Transport. Res. Part. E-Log.* **2014**, *63*, 59–78. https://doi.org/10.1016/j.tre.2014.01.005
52. Worldmeter. Available online: https://www.worldometers.info/ (accessed on 25 August 2021).
53. Michail, N.A.; Melas, K.D. A cointegrating stock trading strategy: Application to listed tanker shipping companies. *J. Ship. Trade* **2019,** *4*, 1–10. https://doi.org/10.1186/s41072-019-0049-2.
54. Atkeson, A. What will be the economic impact of COVID-19 in the US? Rough estimates of disease scenarios. *NBER* **2020**, 1–27. https://doi.org/10.3386/w26867.
55. Ramelli, S.; Wagner, A.F. Feverish stock price reactions to COVID-19. *Rev. Corp. Finance Stud.* **2020**, *9*, 622–655. https://doi.org/10.1093/rcfs/cfaa012.
56. Michail, N.A.; Melas, K.D. Shipping markets in turmoil: An analysis of the covid-19 outbreak and its implications. *Transp. Res. Interdiscip. Perspect.* **2020**, *7*, 100178. https://doi.org/10.1016/j.trip.2020.100178
57. Zheng, H.; Hu, Q.; Yang, C.; Chen, J.; Mei, Q. Transmission path tracking of maritime COVID-19 pandemic via ship sailing pattern mining. *Sustainability* **2021**, *13*, 1089. https://doi.org/10.3390/su13031089.
58. Ikram, M.; Zhang, Q.; Sroufe, R.; Ferasso, M. The social dimensions of corporate sustainability: An integrative framework including COVID-19 insights. *Sustainability* **2020**, *12*, 8747. https://doi.org/10.3390/su12208747.
59. Fontela, E.; Gabus, A. *The DEMATEL Observer*; Battelle Geneva Research Center: Geneva, Switzerland, 1976; pp. 56–61.
60. Saaty, T.L. *The Analytic Hierachy Process*; McGraw-Hill: New York, NY, USA, 1980; p. 324.
61. Yang, Y.O.; Shieh, H.; Leu, J.; Tzeng, G. A novel hybrid MCDM model combined with DEMATEL and ANP with applications. *Int. J. Oper. Res.* **2008**, *3*, 160–168.
62. Opricovic, S. Multicriteria Optimization of Civil Engineering Systems. Ph.D. Thesis, Faculty of Civil Engineering, Belgrade, Serbia, 1998.
63. Liou, J.J.H.; Tsai, C.; Lin, R.; Tzeng, G. A modified VIKOR multiple-Criteria decision method for improving domestic airlines service quality. *J. Air Transp. Manag.* **2011**, *17*, 57–61. https://doi.org/10.1016/j.jairtraman.2010.03.004
64. Qu, G.; Zhao, T.; Zhu, B.; Tzeng, G.; Huang, S. Use of a modified DANP-mV model to improve quality of life in rural residents: The empirical case of Xingshisi village, China. *Int. J. Environ. Res. Public Health* **2019**, *16*, 153. https://doi.org/10.3390/ijerph16010153.
65. Lin, P.; Shiue, Y.; Tzeng, G.; Huang, S. Developing a sustainable long-term ageing health care system using the DANP-mV model: Empirical case of Taiwan. *Int. J. Environ. Res. Public Health* **2019,** *16*, 1349. https://doi.org/10.3390/ijerph16081349.
66. Liu, C.; Liu, B. Using DANP-mV model to improve the paid training measures for travel agents amid the COVID-19 pandemic. *Mathematics* **2021**, *9*, 1924. https://doi.org/10.3390/math9161924.
67. World Shipping Council. Available online: https://www.worldshipping.org/who-we-are-1 (accessed on 25 August 2021).
68. Grammenos, C.T.; Arkoulis, A.G. Macroeconomic factors and international shipping stock returns. *Marit. Econ. Logist.* **2002**, *4*, 81–99.
69. Khurana, S.; Haleem, A.; Luthra, S.; Huisingh, D.; Mannan, B. Now is the time to press the reset button: Helping India's companies to become more resilient and effective in overcoming the impacts of COVID-19, climate changes and other crises. *J. Clean. Prod.* **2020**, *280*, 124466.
70. Lee, P.T.W.; Lin, C.W.; Shin, S.H. A comparative study on financial positions of shipping companies in Taiwan and Korea using entropy and grey relation analysis. *Expert Syst. Appl.*, **2012**, *39*, 5649–5657.
71. Lin, A.J.; Chang, H.Y. Business sustainability performance evaluation for Taiwanese banks—A hybrid multiple-criteria decision-making approach. *Sustainability* **2019**, *11*, 2236.
72. Wang, Y.J.; Lee, H.S. Evaluating financial performance of Taiwan container shipping companies by strength and weakness

indices. *Int. J. Comput. Math.* **2010**, *87*, 38–52.
73. Lee, P.T.W.; Lin, C.W. The cognition map of financial ratios of shipping companies using DEMATEL and MMDE. *Marit. Policy Manag.* **2013**, *40*, 133–145.
74. Shen, K.Y.; Yan, M.R.; Tzeng, G.H. Combining VIKOR-DANP model for glamor stock selection and stock performance improvement. *Knowl Based Syst.* **2014**, *58*, 86–97.