Multicriteria Analysis Of The Sustainability Performance Of The Maritime Activity Of Egypt And Romania

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1. *ABSTRACT:* : The objective of the paper is the examination of the sustainability performance of the maritime activity of Egypt and Romania. Three more countries of interest (China, the Netherlands, and Morocco) were added to the analysis, as being representative of the world's sea trade. The analysis was performed using the multicriteria decisions method (MCDA), with criteria of equal importance. The selected countries were analyzed, based on six relevant available sustainability indicators. According to the results obtained, the most sustainable country for maritime activities proved to be China, followed by Morocco, the Netherlands, Egypt, and Romania. This analysis provides important information and insight about the sustainability performance of the maritime activity in the selected countries from Asia, Europe, and Africa and offers a valid tool for scientifically assessing their sustainability efforts.

Keywords: *sustainability, performance, maritime activity, seaports, sustainable development indicators, multicriteria decision analysis.*

2. INTRODUCTION

The first official definition of sustainable development can be found in the 1987 Brundtland Report of the World Commission on Environment and Development, entitled "Our Common Future", and synthesized the concept as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Report of the World Commission on Environment and Development – Our Common Future, 1987).

The principle behind sustainable development is the continuing concern for the systematic integration of the three essential pillars on which it is based: the environmental, social and economic one (Deselnicu et al., 2017). It is essential that in all aspects of decision-making over the generations, people, organizations and nations take into account their systemic correlation and inter-dependence (Ukaga et al., 2010):

- Environmental sustainability: the ecological component that must be found in every initiative aimed at protecting biodiversity; sustainable organizations aim to reduce their environmental footprint as much as possible;
- Economic sustainability: ensuring the longevity of the company is a responsibility, regardless of market developments; financial profitability is one component of the business, not the only or the most important one.

- Social sustainability: companies act for their own interests, but at the same time, they serve the interests of their employees and of society as a whole. It involves the concern for the welfare of employees and the investment of a part of the company's profit for charitable causes in the community in which it operates.

In 2015, at the meeting of the United Nations General Assembly in New York, a historic document was adopted: The 2030 Agenda for Sustainable Development. Through its 17 objectives, this document aimed to achieve a better future not only for the present generation but also for the next ones (Transforming our world: the 2030 Agenda for Sustainable Development, 2015). Built on the three pillars of sustainable development - economic, social and environmental -, the 2030 Agenda is the one that guides the most important decisions regarding sustainability at the strategic level. Hence, it was quickly adopted by most countries and the European Union.
For a more effective pursuit of directives, on 1 January 2016, the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development, came into force. The 17 Goals are all interconnected, universally apply to all, and are the blueprint to achieve a better and more sustainable future. They address the global challenges humanity faces, including those related to poverty, inequality, climate change, environmental degradation, peace, and justice (World Ports Sustainability Report, 2020). They reflect a balanced agenda of economic, social and environmental goals and objectives (The 2030 Education Agenda: from MDGs, EFA to SDG4, 2018). In order to achieve the SDGs, each country will need to recognize and appreciate the existence of potential trade-offs and develop ways to manage them.

For the maritime activity, the involved organizations address the UN SDGs can be addressed along five main themes, each of them covering a non-exhaustive list of potential topics: Resilient infrastructure, Climate and energy, Community outreach and Port - City dialogue, Safety and Security, Government and Ethics (Port of Rotterdam Authority, 2021a, b; Constantza County, 2021, Port of Constantza Authority, 2021; Sobhy M.M., Mohamed, May Salah E., 2020).
The GRI (Global Reporting Initiative) is the first global standard to support organizations in preparing for the sustainable development report. These reporting standards allow organizations around the world to be more transparent about their economic, environmental, and social impacts (The GRI Standards, 2021). They will also help organizations contribute to the 17 United Nations Sustainable Development Goals (SDGs). GRI has been helping companies prepare a report on the socio-economic and environmental impact since 1999 when it published its first draft of the guidelines.
GRI standards are built on the key concepts and information requirements presented in the G4 Guidelines. The difference is that they are now structured as a set of 36 interdependent, modular standards. Their latest version has three Universal Standards and the three series of Specific Standards and was launched in 2016 (Veira et al., 2021).

3. RESEARCH METHODOLOGY

The research method

The present research used a decision method named multicriteria decision analysis to ascertain and select the best option available. "The decision is the central point of the management activity because it is found in all the functions of the management process. This is the result of a sequential process of information, analysis, and deliberation, called the decision-making process. The decision can be defined as the course of action or the modality, chosen for the achievement of one or more objectives, from a multitude of variants, taking into account certain criteria" (Dobre et al., 2007).

There are several typologies of decisions, but the best known is the classification according to the knowledge degree of the decision-maker regarding the result of different alternatives, which encompasses decisions in conditions of certainty, risk, and uncertainty.
In a decision-making process developed in conditions of certainty, complete information is available, there is only one state of nature with a certain probability (pk), (p1 = 1); thus, the decision- maker knows exactly what will be the result of each variant (alternative).
As opposed, in decision-making processes under risk conditions, there are several possible results for the chosen alternatives, while in decision-making processes under uncertainty conditions, of the number of results, values and probabilities are not known.
The method applied in this study - multicriteria analysis -

is a structured approach used to determine the general preferences between several alternative options, which lead to the achievement of the objectives. This method specifies the objectives pursued and identifies the attributes or indicators (criteria) corresponding to each objective.

The most widely used approach to multicriteria analysis is by using a sequence of five steps.

Therefore, the stages of the decision-making process are the following:

- Step 1: Formulating the problem to be solved and determining the decision criteria;
- Step 2: Determining the performance values for each criterion;
- Step 3: Normalizing the analyzed criteria;
- Step 4: Assigning weights to the decision criteria;
- Step 5: Hierarchy of variants. Calculating the performance score and choosing the best option.

The objective of this method was to determine the performance in terms of sustainability for the maritime activity of five countries of interest involved in international sea trade: China, The Netherlands, Morocco, Romania and Egypt.

4. APPLICATION OF THE MULTICRITERIA DECISION ANALYSIS

The authors followed the classic stages of the decision-making analysis, presented in the next sections.

Step 1: Formulating the problem to be solved and determining the decision criteria

The multicriteria decision-making method was used to investigate the sustainability performance of the selected countries. The authors chose Romania and Egypt as countries of interest. Moreover, another 3 countries were selected for the comparison of their maritime activity: China, as the world's leading country for maritime trade, Netherlands, as Europe's leading country, and Morocco as Africa's leading country in maritime trade (World Shipping Council, 2021). The problem to be solved can be therefore considered a problem of a multicriteria decision in conditions of certainty, using criteria of equal importance.

Table 1 shows the sustainability indicators that were selected for the analysis and the respective sustainability pillar to which they correspond:

Table 1. Sustainability indicators analyzed (2020)

No.	*Sustainability pillar*	*Criteria (Sustainability indicators)*
1	Economic sustainability	Container port throughput (TEU) Fleet growth rate in 2020 (%) Number of port calls Ship building (GT)
2	Social sustainability	Seafarer supply (Officers)
3	Environmental sustainability	Ship recycling (GT)

As it can be observed in Table 1, the indicators for economic sustainability are majoritarian, since UNCTAD is an international trade statistics database. Therefore, for the economic pillar, the criteria included such indicators as Container port throughput (TEU), the Fleet growth rate in 2020 (%), Number of port calls, and Shipbuilding (GT). The social sustainability encompassed the seafarer supply (number of officers), while the environmental sustainability was evaluated through the Ship recycling (GT) indicator.

By comparing selected sustainability criteria of the maritime activity of these countries, the authors aimed to depict a general image of the international maritime activity in the three continents from a sustainability point of view.

Step 2: Determining the performance values for each criterion

For this analysis, six sustainability criteria (indicators) have been selected, for all three sustainability pillars: economic, social, and environmental sustainability.

The six selected indicators were extracted from the UNCTAD database (UNCTAD, 2021) referring to the maritime profile of the 5 countries as reported for the last available year (2020) by UNCTAD. In Table 2, the values related to each criterion chosen for the analysis (Xij) are detailed (Equation 1):

(1) Xij = Performance value of i^{th} country over j^{th} criterion

Table 2. Decision matrix for the analyzed criteria

Crt. no.	Country (ports taken into consideration)	Performance values for selected criteria					
		Container port throughput (TEU)	Number of port calls	Ship building (GT)	Ship recycling (GT)	Seafarer supply (Officers)	Fleet growth rate in 2020 (%)
1	China (Shanghai, Ningbo, Qingdao, Xiamen, Yantian)	245103781	261269	23257200	195486	134294	3,5
2	The Netherlands (Rotterdam, Vlissingen, Moerdijk, Amsterdam, Botlek)	14522209	117420	109164	8430	9667	-1,4
3	Morocco (Tanger Med, Casablanca, Agadir, Nador)	6980958	18002	n/a	n/a	8081	20,3
4	Romania (Constantza)	643725	5331	35783	0	17708	-4
5	Egypt (Port Said, Damietta, El Sokhna, Alexandria, El Dekheila)	5928454	10825	2364	0	7021	3,2

Note: n/a = information not available

Source: compiled from UNCTAD, 2021.

Step 3: Normalizing the analyzed criteria

As is can be observed from Table 2, the analyzed criteria have different units, which makes the evaluation difficult. In order to be able to evaluate the countries with a common measure, the different performance values for the indicators must be normalized. Therefore, at the level of each criterion, the most favorable and unfavorable (beneficial or non-beneficial) consequences were determined (Equation 2; Equation 3); these consequences were then given maximum and minimum utility, respectively.

(2) $$\text{Non beneficial} = \text{Min}(X_{ij})/X_{ij}$$

(3) $$\text{Beneficial} = X_{ij}/\text{Max}(X_{ij})$$

Non-beneficial criteria are those criteria for which a lower value is desirable, while for the beneficial ones, higher values are desirable. As it can be observed, all the criteria considered for the current analysis were considered to be beneficial ones (Table 3):

Table 3. Normalized decision matrix

	Beneficial	Beneficial	Beneficial	Beneficial	Beneficial	Beneficial
	Container port throughput (TEU)	Number of port calls	Ship building (GT)	Ship recycling (GT)	Seafarer supply (Officers)	Fleet growth rate in 2020 (%)
China	1	1	1	1	1	0,172
The Netherlands	0,059	0,449	0,005	0,043	0,072	-0,069
Morocco	0,028	0,069	n/a	n/a	0,060	1
Romania	0,003	0,020	0,002	0,000	0,132	-0,197
Egypt	0,024	0,041	0,000	0,000	0,052	0,158

At this point of the analysis, it became obvious that China, the leading world country in sea international trade, obtained maximum values for most of the economic indicators, as expected. Given its abundant population, it also obtained the highest score for the Seafarer supply (number of officers) criterion. China was followed by Netherlands, the leading country in Europe for international sea trade, which also reported high numbers for the economic indicators.

Surprisingly, Morocco had the highest fleet growth rate in 2020, which made it the reference country for this criterion.

Step 4: Assigning weights to the decision criteria

The next step is to assign the appropriate weightage to the criteria. For the current analysis, the authors have allotted equal weightage to all criteria (20%), as these are considered to be equally important.

After normalizing the criteria, the penultimate step follows, in which each analyzed criterium receives a weight depending on its importance. In the case of the current analysis, it was considered that all six analyzed characteristics have equal weights (16,66%), as presented in Table 4:

Table 4. Weighted normalized decision matrix

Country	Weightage					
	0,1666	0,1666	0,1666	0,1666	0,1666	0,1666
	Container port throughput (TEU)	Number of port calls	Ship building (GT)	Ship recycling (GT)	Seafarer supply: Officers	Fleet growth rate in 2020 (%)
China	0,167	0,167	0,167	0,167	0,167	0,029
The Netherlands	0,010	0,075	0,000	0,007	0,012	-0,011
Morocco	0,005	0,011	n/a	n/a	0,010	0,167
Romania	0,000	0,003	0,000	0,000	0,022	-0,033
Egypt	0,004	0,007	0,000	0,000	0,009	0,026

By multiplying the performance values with the assigned weight, the weighted normalized decision matrix is obtained. This intermediate step is necessary for the calculation of the general Performance score of each analyzed alternative (country).

Step 5: Hierarchy of variants. Calculating the performance score and choosing the best option

Next, we add all the normalized performance values of each analyzed country to get the final Performance score.

After establishing the weights of each criterion, the authors calculated the performance score. The hierarchy of variants is done with the help of a global indicator.

The Performance score, also known as the global utilities indicator (U), represents the sum of all utilities of a variant Vi, and is calculated using the Equation 4:

$$U = \sum_{1}^{1} Vi \quad (4)$$

The performance score is the one that provides the ranking in the multicriteria analysis. It offers a hierarchy of the analyzed countries from the point of view of sustainability performance. All normalized performance values of each alternative (country in this case) are added together in order to obtain the performance score. In an ideal case, the maximum score that an organization can get is equal to 1 (Table 5):

Table 5. Performance score and ranking

Country	Weightage						Performance score	Rank
	0,1666 Container port throughput (TEU)	0,1666 Number of port calls	0,1666 Ship building (GT)	0,1666 Ship recycling (GT)	0,1666 Seafarer supply (Officers)	0,1666 Fleet growth rate in 2020 (%)		
China	0,167	0,167	0,167	0,167	0,167	0,029	0,862	1
The Netherlands	0,010	0,075	0,000	0,007	0,012	-0,011	0,092	3
Morocco	0,005	0,011	n/a	n/a	0,010	0,167	0,193	2
Romania	0,000	0,003	0,000	0,000	0,022	-0,033	-0,007	5
Egypt	0,004	0,007	0,000	0,000	0,009	0,026	0,046	4

Based on the evaluation of the selected sustainability criteria taken into consideration (economic, social, and environmental), China has the highest performance sustainability score of all the five compared countries, indicating the best composite sustainability performance (0,862). This output was by no doubt influenced by its strong economic competitive advantage, resulting in high economic indicators which tipped the scales to its favor. According to the analysis, China is the most sustainable country in maritime activity, taking into account the four sustainability indicators considered as criteria for analysis.

Surprisingly, Morocco ranked second on the top of sustainable countries. Although the information was not available for two important indicators for this country (Ship building and Ship recycling), even by taking the worst-case scenario in which Morocco would have reported 0 (zero) for both these indicators, this country would still be on the second place due to its impressive fleet growth rate (20,3%). Therefore, the leading country in maritime trade in Africa proved to be a worthy competitor in this evaluation, from a sustainability point of view.

The third place was as expected taken by The Netherlands, which holds the biggest operating port in Europe (Rotterdam) and other several important ports (Vlissingen, Moerdijk, Amsterdam and Botlek). Although it registered a negative fleet growth rate in 2020, The Netherlands scored high in economic sustainability indicators (Container port throughput, Number of port calls, and Ship building). Another strong point for the European competitor was its constant preoccupation for environmental sustainability, reflected positively in a high score for Ship recycling.

As for the two countries which constituted the focus of this analysis (Egypt and Romania), they occupied the last two places in the sustainability performance top. Egypt scored higher than Romania, taking the fourth position. Romania was the only country to have a negative score in the analysis. Both countries scored very low on indicators such as Ship Building and Ship recycling, but Egypt definitively reported better values for the economic indicators as Container port throughput (TEU) and Number of port calls. While Romania's performance was better for the social sustainability indicator Seafarer supply (number of officers), Egypt had a better score for the fleet growth rate in 2020 (3,2%).

5. CONCLUSIONS

The objective of the paper was to determine the performance in terms of sustainability for the maritime activity of Egypt and Romania. Three more countries of interest (China, The Netherlands, and Morocco) were added to the analysis, as being representative of the world's sea trade. For this analysis, six selected indicators were chosen (values for the year 2020), representing each of the three pillars that define sustainability: for the economic pillar, the criteria included such indicators as Container port throughput (TEU), the Fleet growth rate, Number of port calls, and Shipbuilding (GT). The social sustainability encompassed the seafarer supply (number of officers), while the environmental sustainability was evaluated through the Ship recycling (GT) indicator.

The multicriteria analysis method was used for decision-

making, in order to examine the sustainability performance of the companies subjected to analysis. According to the results obtained, the most sustainable country for maritime activities proved to be China, followed by Morocco, The Netherlands, Egypt, and Romania. China differed significantly from the other competitors, in particular in what concerns economic indicators related to maritime activity and trade, which are representative of the pillar of economic sustainability. The outstanding performance achieved for these indicators overcame its weak results in the field of environmental sustainability.
Morocco ranked second on the top of sustainable countries. Although the information was not available for two important indicators for this country (Ship building and Ship recycling), even by taking the worst-case scenario in which Morocco would have reported 0 (zero) for both these indicators, this country would still be on the second place due to its impressive fleet growth rate (20,3%).

The third place was taken by The Netherlands, its best comparative advantage being its high economic performance, but also environmental sustainability reflected in a high score for Ship recycling.
Egypt had the fourth place in the sustainability performance top, and Romania was left on the fifth. Egypt had better economic indicators for its maritime activity (as Container port throughput, Number of port calls, and Fleet growth rate), while Romania's scored better for the social sustainability indicator Seafarer supply (number of officers).

This analysis provides important information and insight about the sustainable performance of the maritime activity in the selected countries. First, in order to achieve a high sustainability performance, the countries should pay equal interest and attention to all pillars of sustainability. As sustainability is a complex concept, encompassing at least three equally important areas, even if they score higher in economic indicators, this is not enough to secure a high position in sustainability rankings. They should allot significant resources and support initiatives for the development of the social indicators, as well as the environmental ones.

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