AN ANALYTIC HIERARCHY PROCESS-BASED SURVEY TO INVESTIGATE THE IMPACT OF TERMINALS' SERVICE ATTRIBUTES ON ATTRACTING SHIPPING LINES

Aly Mohamed Elrefaei [(1, 2)i], Ahmed Osman Idris [(1, 2)] and Ahmed Kamel [(3)]
aly.elrefaei@gmail.com   ahmed.idris@aast.edu   ahmadekamel@gmail.com

(1) Construction and Building Engineering Department, Arab Academy for Science, Technology and Maritime Transport (AASTMT), Alexandria, Egypt.
(2) Maritime Research and Consultation Center (MRCC), AASTMT, Alexandria, Egypt.
(3) Head of Research and Development - Damietta Container & Cargo Handling Co.

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1. ABSTRACT:

Freight movement overseas through ports/terminals around the world plays a huge role in the global supply chain. Improving ports/terminals performance has a positive impact on the overall gross domestic product as well as neighbouring regions. Accordingly, port authorities and terminal operators are keen to improve the quality of the services they offer to increase the number of services calling ports (strings) and the cargo volumes at their terminals.

As such, it is important to understand the behaviour of shippers and the preferences of liners, which opens the way to ask the question, what are the important factors that attract liners to a specific port/terminal?

To contribute to this question, this study aims to understand the determinants of liners' terminal choice behaviour using an Analytic Hierarchy Process (AHP)-based survey.

AHP is a structured technique for organizing and analyzing complex decisions based on mathematics and psychology. It is considered a prescriptive data analysis method that divides unstructured choices into several groups and organizes them into hierarchies.

Expert's and previous researches mentioned that low port dues, access of port facilities and port infrastructure are the most important factors control the choice of a port, on the other hand the outcomes of this research proved that, shipping lines and shippers were concerned more with "Port Efficiency" factor which indicates that liners and shippers recently concerned with the level of congestion and the ship turnaround time, next factor is "Connectivity" which give a higher priorities to the ports that has better connectivity to dry ports, storage, and distribution centers.

In addition, understanding the behaviour of different stakeholders plays a major role towards port resilience strategies to adapt to changing conditions and recover positively from unexpected circumstances like the Covid-19 pandemic, which will shorten the road to attaining sustainable ports and highlight required improvements.

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[i] Civil Engineer, M.Sc. Student at the AASTMT, Researcher at the Maritime Research & Consultation Center (MRCC), and a Former Construction Engineer at Al-Jaber & Partners for Construction.

2. INTRODUCTION

Shipping plays an important role in the world economy. Decision-makers worldwide tend to believe that extending the depth of the draft and increasing the length of the berth through mega infrastructure projects is the optimum way to attract more ships to their ports. However, a different point of view may attribute economies oppression to the development of transport infrastructure that can lead to regional imbalances when such infrastructure investments do not pay back efficiently the costs that are spent on them. As a result, such projects would have negative impacts on the economy [2].

An AHP-based survey was designed and used to gather information on container terminals' service attributes (e.g. adequacy of port facilities, port dues, and turnaround time) and stakeholders' (e.g. shipping lines, cargo owners, and terminal operators) terminal choice behaviour by means of online questionnaires and in-person interviews. In addition, the survey was conducted among representatives of ports and terminal operators, specifically the national container companies operating under the supervision of the Holding Company for Maritime and Land Transport (HCMLT) affiliated with the Egyptian government. Respondents' opinions were then organized into a hierarchic system using a pairwise comparison matrix between the attributes.

The main goal which motivates this research is to ensure that future port development projects would reach the required benefits and giving investors trust to participate in the development of future projects. This will be attained through the following objectives:

- Draw guidelines for port authorities and terminal operators regarding which port/terminal characteristics are more important from stakeholders' point of view when selecting a port/terminal of call.
- Guide decision-makers to market requirements and system weaknesses.

In the following sections, this paper will report on: First, the strategies used to elicit the factors considered in the survey. Second, the steps of building the hierarchical system and designing the questionnaire. Third, calculating a mathematical weight to each factor based on the collected data and analyzing the collected data separately for each group of respondents.

3. RESEARCH METHODOLOGY

Analytic Hierarchy Process (AHP) is a structured technique for organizing and analyzing complex decisions based on mathematics and psychology. It is considered a prescriptive data analysis method that divides different choices into groups and manages them into hierarchies [5]. The AHP method is used to convert experts, researchers, and scholars' personal opinions into objective measures [1]. Furthermore, the AHP approach was developed based on the idea that "the best way to conduct a judgment for a group of variables, to decide which variable has a higher priority than the others, is to create a comparison between each pair of elements in different hierarchies" [6]. Furthermore, the AHP method can be applied to demonstrate two types of measurements: relative and absolute. The paired comparison method is used for both measurements to derive priorities based on criteria that serve the main goal. During this study, the AHP method was used to figure out a relative judgment to find the important factors that attract liners to a specific port/terminal. In relative measurement, paired comparisons apply over all alternatives, which guarantees that the lowest alternative in the hierarchy system compares with other alternatives from different levels with respect to the criteria. To start applying the AHP method; first, create a pairwise comparison matrix, then calculate the eigenvector for the matrix and decide a priority vector to the eigenvector to present variables priorities. To evaluate the consistency of the matrix, the eigenvalue is then calculated to decide whether the response will be accepted or rejected.

To apply the AHP method, six steps were followed to reach the required results from applying this method: the first step decide a list of factors and sub-factors from literature reviews and expert opinion sessions, secondly draw the hierarchical structure by deciding the main factors and sub-factors, thirdly establish the pairwise comparison, fourthly find the eigenvalue and the eigenvector, the fifth step is to calculate the consistency ratio for both matrices. Finally, find the weights for each variable and decide which variables have higher priority [9]. These steps are explained in detail in the following sections.

3.1. Establishing a list of factors

Related to the research question, which is, what are the important factors that attract liners to a specific port/terminal?

Expert's opinion sessions were conducted through multiple meetings with different port users to decide which factors attract liners and shippers to a specific port and a specific port terminal. Each expert was asked to list the important factors from their point of view. Researchers and scholars from the logistics field and maritime transport field contributed to these sessions.

After collecting the opinions, a large literature review was conducted through various research papers and studies to compare and decide the final list of the factors and sub-factors that will be listed in the hierarch structure and in the pairwise matrices. The selected factors/sub-factors took into consideration the World Port Sustainability Program (WPSP) which attains the United Nations sustainable development goals through six themes; namely Digitalization, Infrastructure, Health Safety and Security, Environmental Care, Community Building, and Climate and Energy. Each theme has a representative factor in this study to measure the acceptance of the Egyptian market to these factors and to direct decision-makers to which theme they must give a priority to start a sustainability project and invest in this topic.

The list of factors reached nine main factors and 36 sub-factors, which have undergone another round of elimination to reach the final list of 6 main factors and 19 sub-factors, represented in figure 1.

3.1.1. Pilot survey experiment

Before launching the final version of the survey a pilot survey were applied over a group of researchers and experts, the survey were distributed over more than 10 respondents to test the functionality of the designed instrument, respondent were asked after finishing the survey to write any missing factors from their point of view, also state any difficulties they faced while answering the survey, the outcomes of this pilot test were helpful to collect opinions and recommendations to update the survey, there were few adjustments on some sub-factors, also for the online version some adjustments were edited to avoid any misconceptions, infographics and detailed specifications for each factor were added to help the respondent to have more accurate and clear decision.

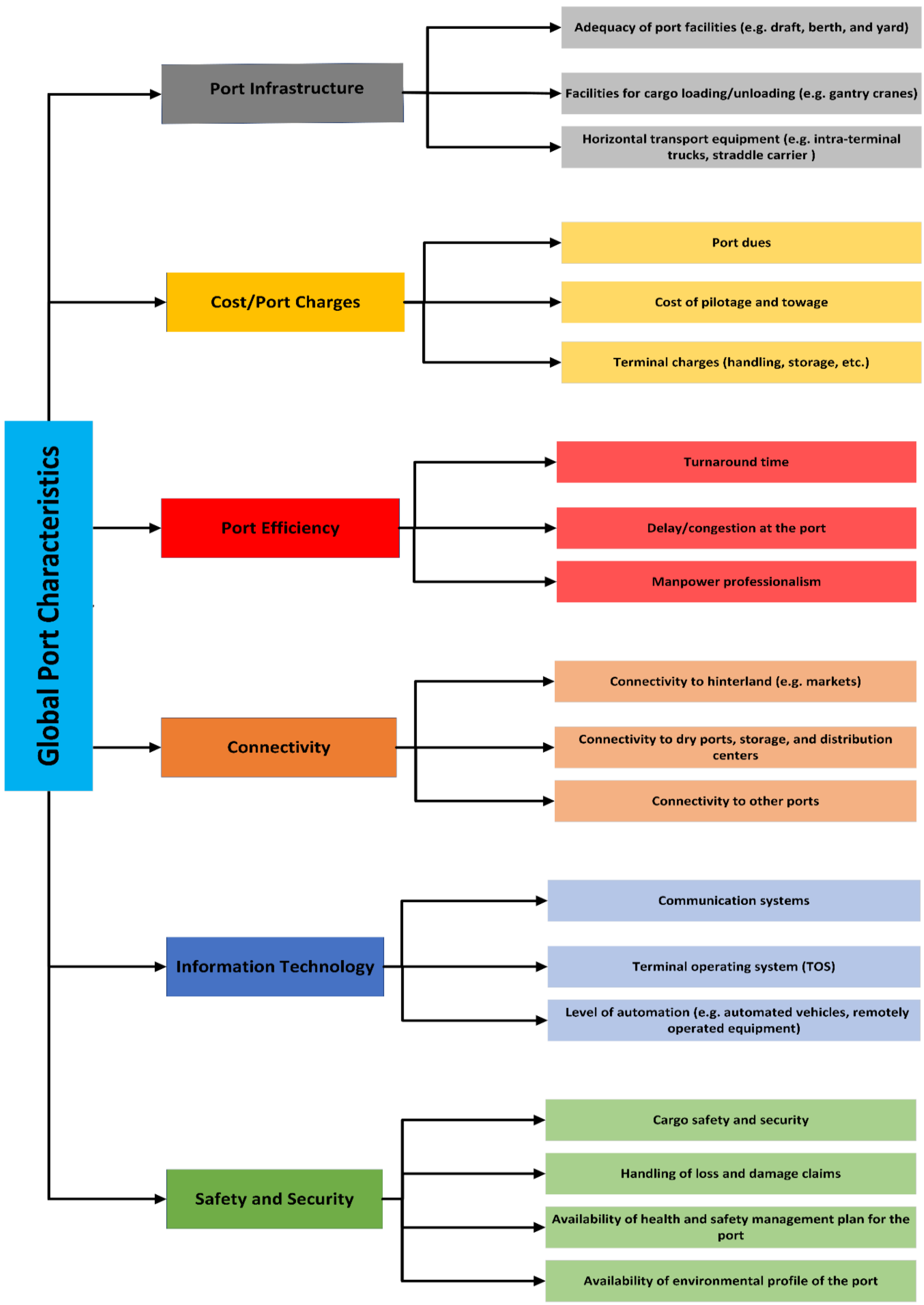

Figure 1: Port characteristics hierarchy chart AHP structured problem

3.2 Establishing the pairwise comparisons:

The scale used in the AHP method is a nominal nine-point scale starting with "equal importance," which is represented by the number 1, and ending with "absolute importance," which is represented by the number 9 [4]. It was important to describe the scale to respondents to understand how to answer the questionnaire to avoid any inconvenient answers and to ensure optimum answers to avoid a high error percentage in the results. The following table was given to the respondents.

Table 1: AHP Evaluation Scale and definition

Evaluation Scale	Definition
1	Equal Important
2	Weak or slight
3	Moderate importance
4	Moderate plus
5	Strong importance
6	Strong plus
7	Very strong
8	Very, very strong
9	Extreme Importance

After drawing the hierarchy chart and using the nominal nine-point scale, it becomes easy to start creating comparisons between the main factors and sub-factors. The next table represents a sample for the comparison tables representing a pairwise comparison between factors.

Table 2: Sample Pairwise comparison

ID	Factor	AHP SCALE																	Factor
1.	Factor 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Factor 2
2.	Factor 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Factor 3
3.	Factor 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Factor 4
4.	Factor 2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Factor 3
5.	Factor 2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Factor 4
6.	Factor 3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Factor 4

3.3 Calculation of criteria weights:

3.3.1 Create comparison matrices:

To find the relative importance between two elements/factors, the ratio for relative importance is set by using a nominal scale, and the values are 1/9, 1/8, …, 1/2, 1, 2, 3, …, 8, 9. Table (2), shows a pairwise comparison, as long the left (yellow) side of table will be constant factors and the right (blue) side is the changing factors then the next steps will be applied. If the respondent chooses a value from the right side, then the value will be projected in the main diagonal of "matrix A" as a fraction number "1/2, 1/3, ...,1/9" on the other side, if the respondent chooses a value from the (yellow) left side, it will be presented as "1, 2, 3, ..., 8, 9".

AHP method used to convert respondent choices to matrix data, the matrix is divided into two triangles upper triangle and a lower triangle.

The upper triangle in gray color in "Matrix A" is the main diagonal filled with the data first. This matrix is reciprocal matrix, elements below the diagonal will be filled second, and it will be a reciprocal values from the equivalent values. In the matrix if the factor meets itself the value will equal "1". For example: in Table (2), in first row if the respondent choose that "factor 1" has an "Extreme Importance" than "factor 2" then put "9" in the matrix, in fourth row if the respondent choose that "factor 3" has "Moderate importance" than "factor 2" so 1/3 projected in the matrix. When similar factors meets in the matrix put "1", e.g. "factor 1" meets "factor 1" the value will be "1" in "matrix A".

Matrix A=

	F1	F2	F3	F4
F1	1	9	4	7
F2	1/9	1	1/3	1
F3	1/4	3	1	2
F4	1/7	1	1/2	1

Matrix A_n=

	F1	F2	F3	
F1	0.66	0.64	0.69	0.64
F2	0.07	0.07	0.06	0.09
F3	0.17	0.22	0.17	0.18
F4	0.09	0.07	0.09	0.09

After creating the comparison matrix "A", a sum for each column is calculated to start with the next step, which is normalizing the comparison matrix by dividing each value in the matrix by the sum of the relative column, to create new matrix "A_n" after calculating the normalized matrix, for each row in the new matrix the average values calculated which give a weight (W) for each alternative which represents the eigenvector, as presented in Table (4). Now each alternative has a weight, and it can be arranged from the higher importance to the lower importance. But a consistency check is required to decide whether this judgment and weights are accepted or not, to calculate the consistency ratio CR and consistency index CI (eigenvector) of a comparison matrix A [8].

$$CR = \frac{CI}{RI} \quad (1) \qquad CI = \frac{\lambda \max - n}{n-1} \quad (2) \qquad (AW) = \text{priority matrix} * \text{criteria weight} \ (3)$$

First, create a new matrix by multiplying matrix A by the eigenvector (W), call the new matrix "AW", create the vector "λ" by dividing the elements in "AW" by the corresponding elements of (W), to calculate the maximum eigenvalue "λmax" the average of the values of "λ" will be taken. To find the consistency ratio as per equation 1. RI is a constant value related to the numbers of the factors in the matrix. If CR < 10%, then the matrix is considered to be consistent, and the judgment is accepted [8].

Table 3: Saaty's Standard Random Index (RI) Scale

Number of Decision Alternatives (n)	2	3	4	5	6	7	8	9	10	11	12	13
Random Index, RI	0.16	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.58	1.56

A consistency check should be calculated for each response individually, and the judgment that CR exceeds 10% will be re-sent to the respondent to re-answer it. In case of facing any difficulties in reaching the respondent, the response will be eliminated for the inconvenience in case it was difficult to reach the respondent. After calculating the matrices and testing the consistency for each answer separately, final step is summing the data in one final aggregate matrix. To find the Aggregation (combined results) of individual judgments for all participants, the weighted geometric mean method should be used because it reflects better the preference information in the pairwise comparison and reduces the error margin rather than using the arithmetic mean method [3]. Check the consistencies of aggregated matrices, then calculate the weights for each factor representing the total responses.

Table 4: Steps and final results to calculate CI & CR

	Weight (W)	AW	λ	λ_{max}	CI	CR
F1	0.6572	2.65	4.03	4.02	0.72%	0.80%
F2	0.0732	0.29	4.00			
F3	0.1839	0.74	4.03			
F4	0.0857	0.34	4.02			

4. RESULTS AND DISCUSSION

The main purpose of using the AHP method in this study is to know which alternatives affect the choice of shippers and shipping lines to a certain port/container terminal. The pairwise comparison tables were prepared and explained well to the respondents before starting to answer the surveys to avoid any misunderstanding and to have a lower error percentage. The survey was distributed online and through personal interviews, and the surveys were available in two languages, Arabic and English, to expand the circle of the respondents and to ease the process of the respondents. As a matter of fact, this research is concerned with the Egyptian maritime terminal ports and local terminal companies. It is preferable for some respondents to have an Arabic copy of the survey, which was a replica of the English version.

4.1 Sample size:

The surveys were distributed and sent to 50 respondents, decision-makers, port users, and experts in the maritime transport and logistics field. The experiment sample answers were diverse and included responses from different groups, which were: shipping lines, shippers, terminal operators, port authorities, researchers, scholars, and other partners dealing with shipping and port services.

As mentioned before, the survey was answered through an online version and personal interviews, only 45 responses were received back, and after the analysis stage, five responses were incomplete and inconsistency, so these answers were eliminated. As a result, the final sample size is 40 responses. The graph below illustrates the percentage of responses for each group of users:

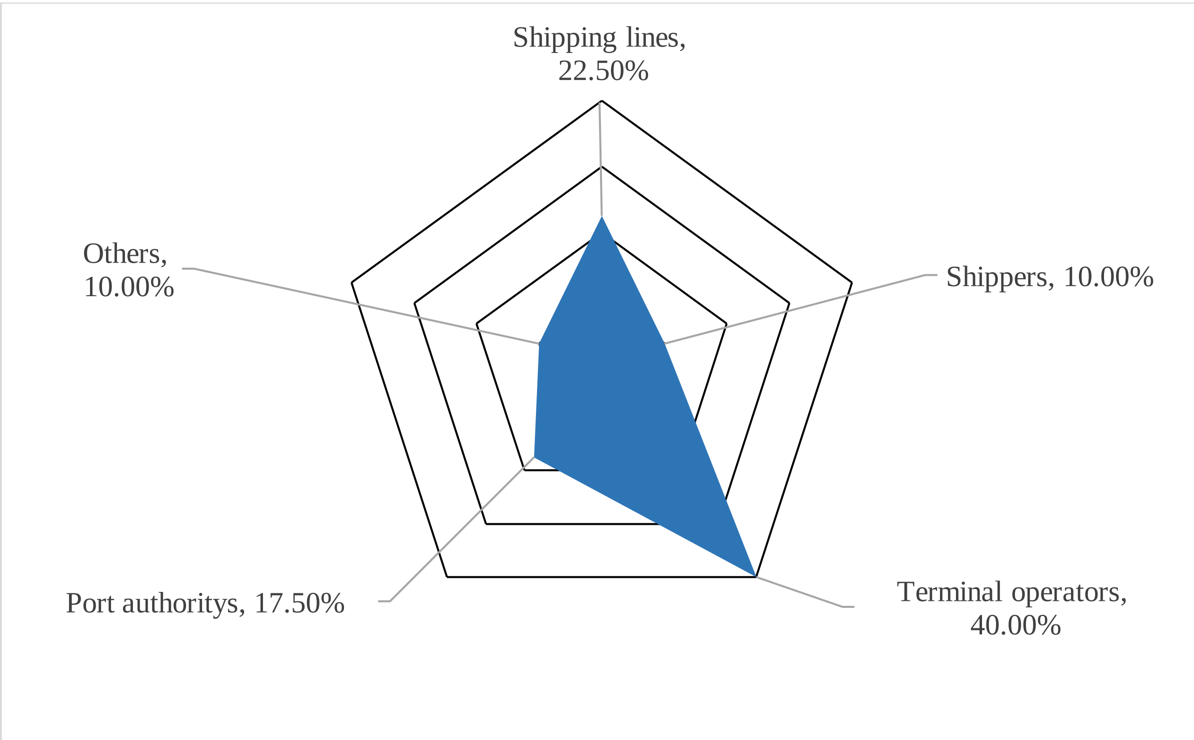

Figure 2: percentage of responses for each group

The data in the previous figure shows that almost 57% of the answers were from the terminal operators and port authorities, and the rest of the responses were from port users like shippers and shipping lines. This ratio was almost half for each team, creating a balance in the final results.

4.2 Aggregate responses data analysis

4.2.1 Consistency Test: The table below shows the consistency tests for the 40 responses.

Table 5: consistency tests for all responses

Criterion	Test Value	Sub-Criterion	Test Value
Port Infrastructure	CI= 0.49% CR= 0.4%	Equipment availability	CI= 0.001% CR= 0.001%
		Adequacy of port facilities (e.g. draft, berth, and yard)	
		Facilities for cargo loading/unloading	
Cost/Port Charges		Port dues	CI= 0.11% CR= 0.13%
		Cost of pilotage and towage	
		Terminal charges (handling, storage, etc.)	
Port Efficiency		Turnaround time	CI= 0.23% CR= 0.3%
		Delay/congestion at the port	
		Manpower professionalism	
Connectivity		Connectivity to the hinterland (i.e. markets)	CI= 0.04% CR= 0.1%
		Connectivity to dry ports, storage, and distribution centers	
		Connectivity to other ports	
Information Technology		Communication systems	CI= 0.12% CR= 0.14%
		Terminal Operating System (TOS)	
		Level of automation	
Safety and Security		Cargo safety and security	CI= 0.23% CR= 0.4%
		Handling of loss and damage claims	
		Availability of health and safety management plan for the port	
		Availability of environmental profile of the port	

The hierarchical consistency test result of the data collected from the experts is shown in table (5). The consistency test between the main criterion (main factors), which represents the consistency between "Port Infrastructure", "Cost/Port Charges", "Port Efficiency", "Connectivity", "Information Technology", "Safety and Security" the test results were CI= 0.49% and CI= 0.4% which are less than < 10%, so it is accepted result. Moreover, the consistency test for the sub-criterion is also below the limit, which means that all the judgments accepted and the pairwise comparison matrix of the target hierarchy are sacksful, so the next step is to calculate the weight for each variable.

4.2.2 Relative weight of criteria.

Table 6: Relative weight of criteria

Criterion	Weight	Sequence	Sub-Criterion	Weight	Sequence	Overall Weight	Sequence
Port Infrastructure	14%	5	Equipment availability	0.448	1	6%	5
			Adequacy of port facilities (e.g. draft, berth, and yard)	0.338	2	5%	12
			Facilities for cargo loading/unloading	0.215	3	3%	17
Cost/Port Charges	14%	4	Port dues	0.34	2	5%	11
			Cost of pilotage and towage	0.19	3	3%	19
			Terminal charges (handling, storage, etc.)	0.47	1	7%	4
Port Efficiency	24%	1	Turnaround time	0.402	1	10%	1
			Delay/congestion at the port	0.363	2	9%	2
			Manpower professionalism	0.236	3	6%	7
Connectivity	13%	6	Connectivity to the hinterland (i.e. markets)	0.26	3	3%	16
			Connectivity to dry ports, storage, and distribution centers	0.411	1	5%	9
			Connectivity to other ports	0.329	2	4%	13
Information Technology	17%	3	Communication systems	0.299	2	5%	10
			Terminal Operating System (TOS)	0.481	1	8%	3
			Level of automation	0.22	3	4%	14
Safety and Security	18%	2	Cargo safety and security	0.343	1	6%	6
			Handling of loss and damage claims	0.189	3	3%	15
			Availability of health and safety management plan for the port	0.312	2	6%	8
			Availability of environmental profile of the port	0.155	4	3%	18

After applying the equations to calculate the element weights in different hierarchies and the consistency test for the overall 40 responses, the analyses proceed as follows: first, for the pairwise comparison matrix of the six criteria of "Port Infrastructure", "Cost/Port Charges", "Port Efficiency", "Connectivity", "Information Technology", and "Safety and Security" and the target hierarchy "The important factors that attract liners to a specific port/terminal", the weights are analyzed in (Table 6). The next graphs represent the arrangement of main factors and sub-factors. As shown in figure 3, port efficiency has the highest priority with 24%, then followed by safety and security factors, while connectivity, port infrastructure, and cost came last in the arrangement. The element weights of the criteria are multiplied by the relative weight of the corresponding elements of the sub-criteria to calculate the total weight of such elements to the target hierarchy [4]. Figure 3 shows that "Turnaround time" came first in the arrangement with 10%, followed by connectivity to other ports and communication systems. While factors like "port dues" and "Adequacy of port facilities" came last in the arrangement of the Sub-criteria sequence for overall evaluation as shown figure 4.

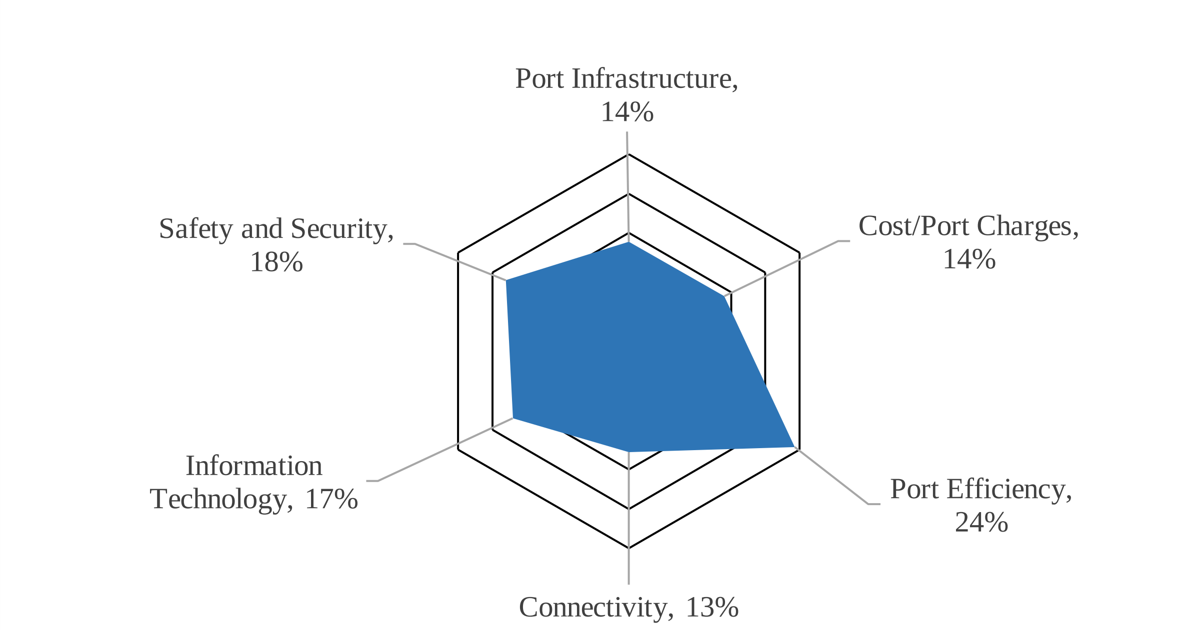

Figure 3: Main Criterion weights

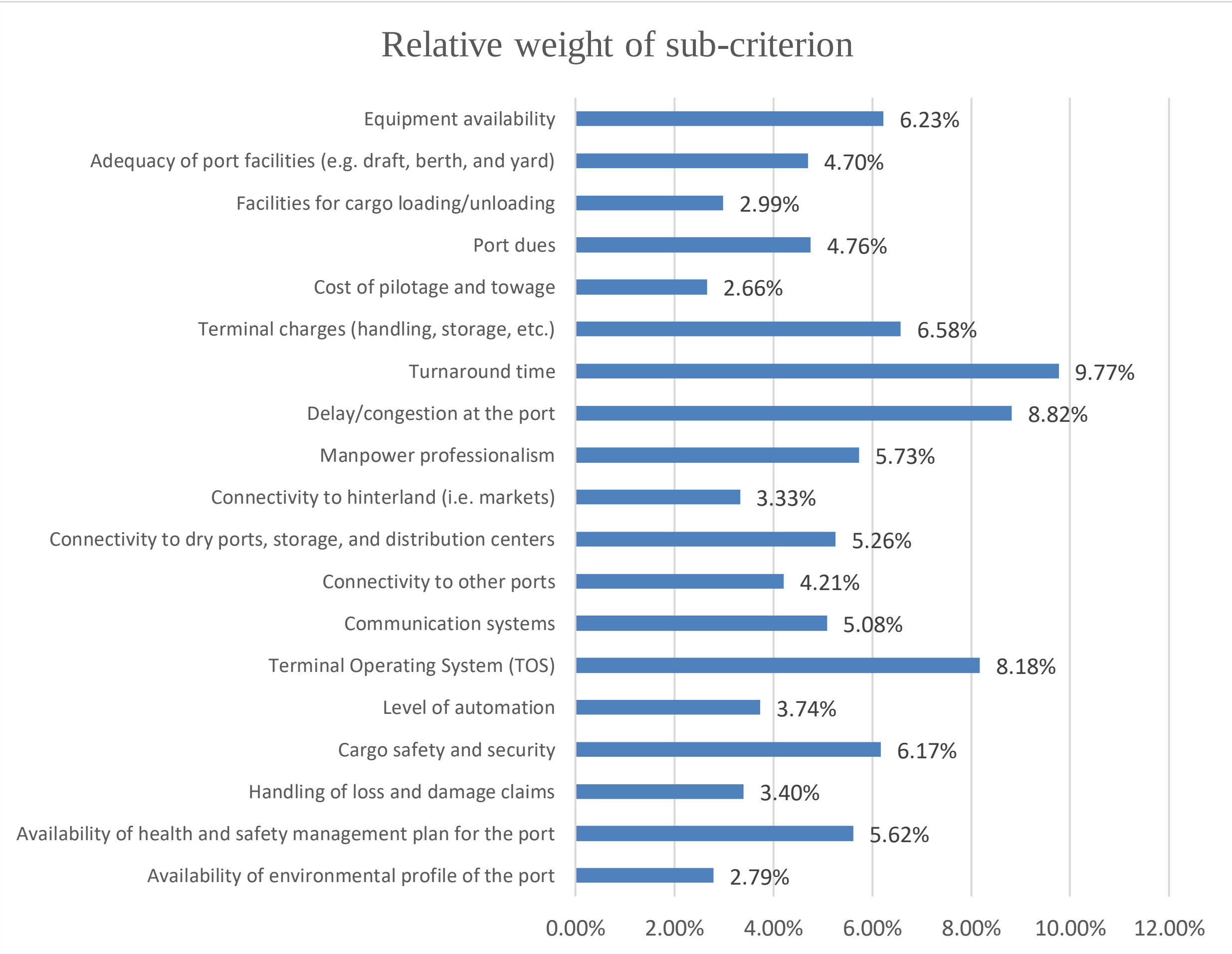

Figure 4: Sub-criteria sequence for overall evaluation

5. DATA ANALYSIS OF THE DIFFERENT GROUP RESPONSES

The study put a higher importance on creating a comparison between decision-makers (port authorities and terminal operators), and port users (shippers, shipping lines, and others (researchers, scholars, and other partners deal with shipping and port services), to find is there a gap between those two teams or they think in the same way. This balance helps to avoid any bias in results to one side over the other side.

5.1. Decision-makers (port authorities and terminal operators)

Table 7: Decision-makers (port authorities and terminal operators) data analysis

Criterion	Weight	Sequence	Sub-Criterion	Weight	Sequence	Overall Weight	Sequence
Port Infrastructure	15%	5	Equipment availability	0.488	1	7.1%	5
			Adequacy of port facilities (e.g. draft, berth, and yard)	0.295	2	4.3%	11
			Facilities for cargo loading/unloading	0.216	3	3.2%	15
Cost/Port Charges	15%	4	Port dues	0.315	2	4.6%	9
			Cost of pilotage and towage	0.14	3	2.1%	19
			Terminal charges (handling, storage, etc.)	0.545	1	8.0%	4
Port Efficiency	23%	1	Turnaround time	0.452	1	10.4%	1
			Delay/congestion at the port	0.293	2	6.7%	6
			Manpower professionalism	0.254	3	5.8%	8
Connectivity	9%	6	Connectivity to hinterland (i.e. markets)	0.255	3	2.3%	18
			Connectivity to dry ports, storage, and distribution centers	0.345	1	3.2%	16
			Connectivity to other ports	0.4	2	3.7%	13
Information Technology	18%	3	Communication systems	0.245	2	4.3%	12
			Terminal Operating System (TOS)	0.505	1	8.9%	2
			Level of automation	0.25	3	4.4%	10
Safety and Security	21%	2	Cargo safety and security	0.289	1	6.1%	7
			Handling of loss and damage claims	0.129	3	2.7%	17
			Availability of health and safety management plan for the port	0.407	2	8.6%	3
			Availability of environmental profile of the port	0.175	4	3.7%	14

For the main criterion arrangement in table 7, Port Efficiency has the highest priority with 23%, then followed by safety and security factors, while port infrastructure, cost, and connectivity came last in the arrangement. The sub-criterion table 7 shows that "Turnaround time" came first in the arrangement with 10.4%, followed by the Terminal Operating System (TOS) and Availability of health and safety management plan for the port. While factors like "Facilities for cargo loading/unloading" and "Adequacy of port facilities" came last in the arrangement.

5.2. Port users (shippers, shipping line, and others)

Table 8: Port users (shippers, shipping line, and others)

Criterion	Weight	Sequence	Sub-Criterion	Weight	Sequence	Overall Weight	Sequence
Port Infrastructure	12.5%	6	Equipment availability	0.392	1	4.90%	10
			Adequacy of port facilities (e.g. draft, berth, and yard)	0.398	2	5.00%	8
			Facilities for cargo loading/unloading	0.21	3	2.60%	18
Cost/Port Charges	12.8%	5	Port dues	0.36	2	4.60%	13
			Cost of pilotage and towage	0.273	3	3.50%	15
			Terminal charges (handling, storage, etc.)	0.368	1	4.70%	11
Port Efficiency	25.3%	1	Turnaround time	0.33	1	8.30%	3
			Delay/congestion at the port	0.466	2	11.80%	1
			Manpower professionalism	0.205	3	5.20%	7
Connectivity	19.4%	2	Connectivity to the hinterland (i.e. markets)	0.257	3	5.00%	9
			Connectivity to dry ports, storage, and distribution centers	0.5	1	9.70%	2
			Connectivity to other ports	0.243	2	4.70%	12
Information Technology	15.9%	3	Communication systems	0.382	2	6.10%	5
			Terminal Operating System (TOS)	0.438	1	7.00%	4
			Level of automation	0.179	3	2.90%	16
Safety and Security	14.1%	4	Cargo safety and security	0.393	1	5.50%	6
			Handling of loss and damage claims	0.289	3	4.10%	14
			Availability of health and safety management plan for the port	0.198	2	2.80%	17
			Availability of environmental profile of the port	0.12	4	1.70%	19

For the main criterion arrangement in table 8, port efficiency have the highest priority with 25.3%, then followed by the Connectivity factor, while port infrastructure and cost came last in the arrangement. The sub-criterion in table 8 shows that "Delay/congestion at the port" came first in the arrangement with 11.8%, followed by Connectivity to dry ports and Turnaround time. While factors like "Facilities for cargo loading/unloading" and "Availability of the environmental profile of the port" came last.

5.3 Shipping lines and port terminals

The preferences of shipping lines responses as compared to terminal operators preferred factors, shipping lines sees that port efficiency have the highest priority, followed by information technology (IT) projecting their needs for better automated ports and good communication and operating systems like (TOS), their preferable factors shows that avoiding congestion and delays are the main aspects liners looking for before choosing the port, while port dues and infrastructure came last in the arrangement. Terminal operators gave higher priority to port safety and security, then port efficiency came second followed by information technology, this arrangement is close to the preferable factors for liners. The chosen factors show that terminals operators and liners believe that fully automated ports will be the future of less congested ports.

6. CONCLUSIONS

The main purpose of this study is to find the factors that affect the choice of shippers and shipping lines of a specific port/container terminal, by using AHP method. In this study, pairwise comparisons were conducted between various variables chosen carefully by the help of the elite experts in maritime and logistics field, literature reviews, and personal interviews with experts. It was deeply believed that reducing the costs of customs, tariffs and other port dues, also, improving the infrastructure for the ports by increase the depth of the draft and extend the length of the berth also, provide more spaces for yards, will be the dominating factors. However, the aggregated results showed that "Port Efficiency" have the highest priority with 24%, which represents the time consumed in the port, and the congestion in the ports, the highest two factors in the sub-factors were "turnaround time and congestion at the port". This indicates strongly that constructing new infrastructure in the port will not solve the problem of congestion it will only delay it. As such, decision-makers need to start thinking from a new perspective to find resilient solutions for congestion, using incentives and disincentives to attract shippers to ports that have lower traffic and to reduce the congestion in congested ports. The second main factor was safety and security. This proves the researcher's point of view that port users, after the pandemic, starts to think in a different way regarding the importance of health in the port community, and more automated ports with less human interference. While connectivity, port infrastructure, and the cost came last in the arrangement. In the comparison between decision-makers and port users, the data gave hope that the future of port planning may have a better improvement because the preferable factors for both teams were close to each other both teams gave the highest priority to "port efficiency" and "information technology". Such results improve the hopes that the future of the Egyptian port terminals will have higher trading rates, as long the decision-makers are aware of market preferable changes, and nowadays a more sustainable and environmental solution is required to have a resilient port that capable of avoiding any unexpected catastrophes and of rebuilding itself again fast against any unexpected issues. To solve the issue of port congestion, which came as a top priority in this research, decision-makers need to focus on projects that support the following themes from the WPSP list: Information Technology and Health Safety and Security; as evident in data collected from both shippers/liners and operators.

7. REFERENCES

1. Canco, I.; Kruja, D.; Iancu, T. AHP, a Reliable Method for Quality Decision Making: A Case Study in Business. Sustainability 2021, 13, 13932. https://doi.org/10.3390/su132413932
2. E V Gudkova and E A Zaostrovskikh 2021 IOP Conf. Ser.: Earth Environ. Sci. 666 062040
3. Krejčí, Jana; Stoklasa, Jan (2018). Aggregation in the analytic hierarchy process: Why weighted geometric mean should be used instead of weighted arithmetic mean. Expert Systems with Applications, 114(), 97–106. doi:10.1016/j.eswa.2018.06.060
4. Liang, T.-C.; Peng, S.-H. Using Analytic Hierarchy Process to Examine the Success Factors of Autonomous Landscape Development in Rural Communities. Sustainability 2017, 9, 729. https://doi.org/10.3390/su9050729
5. Saaty, T.L. "Decision Making with the Analytic Hierarchy Process." International Journal of Services Sciences 1(1), (2008): 83-98.
6. Sipahi, S.; Timor, M. The analytic hierarchy process and analytic network process: An overview of applications. In Management Decision; Emerald Publishing: Bradford, UK, 2010.
7. Siyuan Tang et al 2020 IOP Conf. Ser.: Earth Environ. Sci. 526 012174
8. Thomas L. Saaty (1990). How to make a decision: The analytic hierarchy process. , 48(1), 9–26. doi:10.1016/0377-2217(90)90057-i
9. Vikram Singh and Somesh Sharma 2022 IOP Conf. Ser.: Mater. Sci. Eng. 1259 012038