

The Port Resilience Level at The Kemaman Port Consortium

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Abstract: Resilience in ports is an important thing that must be considered. This study focuses on the resilience elements conducted to measure the current level of resilience of the targeted areas of Konsortium Pelabuhan Kemaman using an analytical hierarchy process. Resilience is developed based on four factors: responding, monitoring, learning, and anticipating. This study aims to identify an aspect of resilience, rank the most critical element at the port, and recommend the best solution to improving resilience in Consortium Port Kemaman. This study involved ten representatives from the operation, pilotage, and safety departments at Konsortium Pelabuhan Kemaman. Based on the results, recommendations for improving resilience are made by the authors to the port. Higher values of resilience are equivalent to increased preparedness to cope with climate change and disasters.

Keywords: *Resilience, Element, Analytical Hierarchy Process (AHP)*

1. Introduction

On Peninsular Malaysia's east coast, you can find Kemaman Port. Steel mills, crude oil terminals, gas processing facilities, refineries, and petrochemical complexes are all serviced by this port. One of Malaysia's deepest seaports is this one. With three multipurpose berths, one liquid chemical berth, and one LPG export terminal, it quickly becomes the new entry point to the Asia-Pacific region [9]. A supply base for oil companies working off Terengganu's coast can be found at Kemaman Port. With its privatization, Kemaman Port is well-positioned to grow quickly alongside the region's manufacturing and petrochemical sectors.

The East Wharf and Liquid Chemical Berth (LCB) terminals of the port of Kemaman are run by Consortium Pelabuhan Kemaman Sdn. Bhd. (KPK). This port can handle general and liquid bulk cargo and vessels up to 150 000 DWT.



Figure 1. Map in Kemaman Port

1.1 Service Provided

Table 1: Type of Service Provided

Type	Explanation
East wharf	<ul style="list-style-type: none"> 648 meters length Maximum draught of 16.4 meters

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	<ul style="list-style-type: none"> • One of the deepest seaports in Malaysia • Handling vessels up to 150 000 DWT • Handle various types of cargo, dry bulk and liquid bulk. • A regional Centre for transshipment activities as well as cargo consolidation and distribution activities
Liquid Chemical Berth (LCB)	<ul style="list-style-type: none"> • Handle liquid chemical cargo. • Fully operational to cater to the needs of chemical-related industries. • 289 meters long • Capable of accommodating vessels up to 150 000 DWT • Has space available for 50 pipelines and 6 loading arms. • Fully equipped with safety features
Marine Services	<ul style="list-style-type: none"> • Tugboats • Traffic control • Pilotage and service boats • Cargo handling services (stevedores, drainage, forklift) • Rental of warehouse and open yard • Supply of freshwater • Minor repair and other support services

then, the data must be gathered and assessed using pairwise comparisons of the feature; and finally, the priority weights of variables or items at each level must be computed [3].

2.2.1. Structural Hierarchy Model

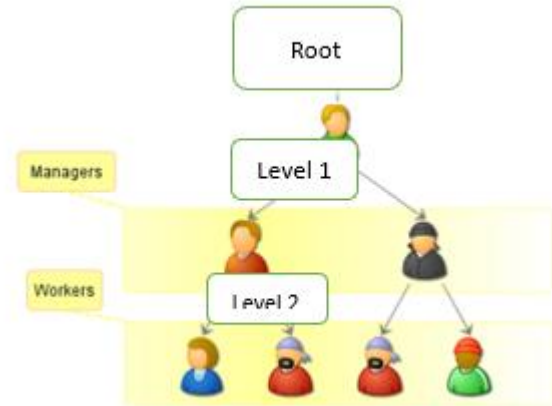


Figure 2: Example of The Hierarchy Structural Model (Sources: Wikipedia)

From the literature review of the case study, the model will look like the figure above [4]. The root will be resilience, and level 1 will be the central element of resilience. Level 2 is the sub-criteria for resilience that links with the main criteria, level 1. An AHP Hierarchy is a structured means of modeling the decision at hand. It consists of an overall goal, a group of options or alternatives for reaching the goal, and factors or criteria that relate the choices to the goal. The design of any AHP hierarchy will depend not only on the nature of the problem at hand but also on the participants' knowledge, judgments, values, opinions, needs, wants, etc. in the decision-making process.

2.2.2. Analytic Hierarchy Process (AHP)

2. Materials and Methods

2.1. Data Collection

There are a few ways data was collected during the conduct of this research. Firstly, in the early stages, a literature review was done to understand the problem of this research. A literature review was also done to determine what resilience means and its elements. Next, an interview was conducted with the experts in the selected department, the operation department, and the safety department of the Kemaman Port Consortium. In addition, the questionnaire has also been distributed to the selected population according to the department to collect the data. 2.2. Data Analysis In 1980, Saaty created the analytical hierarchy process (AHP) [5]. It was used to compare and rank the determining factors and is a technique for decision-making in the presence of many criteria [2]. It offers a numerical scale for quantifying both qualitative and quantitative performance. There are three steps in this process: first, the problem must be segmented and organized into a hierarchy of subproblems;

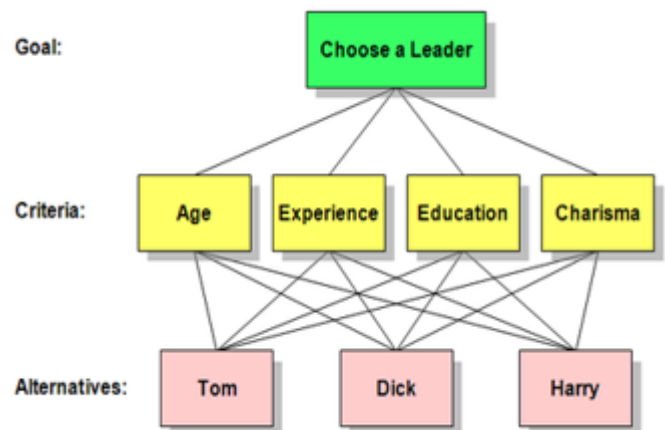


Figure 3: Example of Data Analysis From Ahp (Source: Wikipedia)

The figure above shows an example of the data analysis that will be done from the questionnaire. From this data analysis, the goal can be achieved by using the Analytic

Hierarchy Process (AHP) method and its software.

2.2.3. How does the AHP work?

The AHP weighs various alternatives and assessment criteria before selecting the best one. It is crucial to remember that some of the criteria may be in conflict. Therefore, it is not always true that the optimal option is the one that maximizes every criterion instead of the one that achieves the optimum trade-off between the various criteria. According to the decision maker's pairwise comparisons of the assessment criteria, the AHP creates a weight for each criterion. The corresponding criterion is more crucial the higher the importance. The decision maker then compares each choice based on that criterion in pairs, and the AHP then assigns a score to each option based on that comparison. The better a choice performs in relation to the evaluated criterion, the higher the score [7]. To arrive at a final score for each choice and a corresponding ranking, the AHP combines the option scores with the weights assigned to the criteria. The overall score for a specific opportunity is the weighted average of the results for each criterion.

2.5. Features of the AHP

Because the scores, and consequently the final ranking, are based on pairwise relative evaluations of both the criteria and the options provided by the user, the AHP is a very versatile and effective tool. Thus, the AHP can be viewed as a tool that converts the decision-evaluation maker's qualitative and quantitative evaluations into a multi-criterion ranking. The AHP is also easy because it is not necessary to create a sophisticated expert system that incorporates the decision-makers knowledge. The decision-makers experience always influences the AHP's calculations. However, the AHP may need the user to perform numerous evaluations, particularly for issues with numerous criteria and alternatives. Every evaluation is simple because all that is needed is for the decision-maker to state how two options or criteria compare. Yet, the workload of the evaluation activity may become excessive. With more criteria and possibilities, there are quadratically more pairwise comparisons. For example, building the weight vector requires $4(109/2) = 6$ comparisons when comparing 10 alternatives on 4 criteria, and building the score matrix requires $4(109/2) = 180$ pairwise comparisons when comparing 10 alternatives on 4 criteria. To lessen the workload of the decision maker, the AHP can be fully or partially automated by defining appropriate criteria for pairwise comparisons.

2.6. Analytical Hierarchy Process (AHP) Calculation for Consistency Ratio (CR).

Deciding can be viewed as selecting one option from a range of alternatives based on some standard or criterion. To accomplish the relative ranking of the alternatives

concerning the problem, it is necessary to assess numerous criteria, evaluate alternatives based on each criterion, and then combine these evaluations. It could be necessary to base a judgment on more than one criterion rather than just one. The issue is exacerbated when there are three or more specialists whose perspectives must be considered in the decision-making process. The reliance on the intuition, experience, and judgment of informed people known as experts results from insufficient quantitative information. Perhaps the earliest method used was the weighted-sum method (WSM), also known as the decision matrix approach. This assesses every alternative concerning every criterion and multiplies that assessment by the criterion's weight. To determine the rank of the alternative, this product is added up across all the criteria for that specific alternative. Mathematically,

The equation as normal text:

$$R_i = \sum_{j=1}^N a_{ij}w_j \quad (1)$$

Where R_i is the rank of the i th alternative, a_{ij} is the actual value of the i th alternative in terms of the j th criterion, and w_j is the weight or importance of the j th criterion.

2.7. The AHP – Step by Step

The AHP offers a way to divide the issue into a hierarchy of smaller issues that are simpler to understand and evaluate from various perspectives. The subjective evaluations are transformed into numerical values and analyzed to rank each alternative on a numerical scale. The following steps can be used to explain the AHP methodology:

Step 1: The issue is broken down into a hierarchy of objectives, standards, substandard, and solutions. The most original and crucial phase of decision-making is this. The AHP approach's foundation is the decision issue's hierarchical structuring.

Step 2: Information is gathered from professionals or decision-makers following the hierarchical structure in the paired comparison of alternatives on a qualitative scale, as stated below.

Table 1: The Ratio of Pairwise Comparison

Linguistic Meaning	Numerical Assessment
High	3
Slightly high	5
Very high	7

Extremely high	9
Intermediate values between two adjacent	2, 4, 6, 8
Equal	1
Low	1/3
Slightly low	1/5
Very low	1/7
Extremely low	1/9
Intermediate values between two adjacent	1/2, 1/4, 1/6, 1/8

Step 3: A square matrix is created using the pairwise comparisons of the various criteria generated in Step 2. The matrix's diagonal members are 1 in number. The reciprocal of the (I, j) element is the (j, I element. If the element's value (I, j) is greater than 1, the criterion in the ith row is preferable to the criterion in the jth column; otherwise, the jth column's criterion is preferable to the ith row's criterion.

Table 3: Pairwise Comparison Matrix of Main Factor

	Factor 1	Factor 2	Factor 3
Factor 1	1	1/3	5
Factor 2	3	1	7
Factor 3	1/5	1/7	1

Step 4: The comparison matrix's major eigenvalue and the related normalized right Eigenvector indicate the relative weights assigned to the various criteria. The components of the normalized Eigenvector are referred to as weights for the alternatives and ratings for the criteria or sub-criteria.

Table 2: Priority Vector

	Factor 1	Factor 2	Factor 3
Factor 1	1	1/3	5
Factor 2	3	1	7
Factor 3	1/5	1/7	1

Sum	21/5	31/21	13
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Table 3: Priority Vector

	Factor 1	Factor 2	Factor 3
Factor 1	5/21	7/31	5/13
Factor 2	15/21	21/31	7/13
Factor 3	1/21	3/31	1/13
Sum	1	1	1

The normalized principal Eigenvector is also called the priority vector. Since it is normalized, the sum of all elements in the priority vector is 1. The priority vector shows relative weights among the things that we compare. In our example above, factor 1 is 28.28%, factor 2 is 64.34%, and factor 3 is 7.38%. The preferable factor is factor 2, followed by factor 1 and factor 3. In this case, we know more than their ranking. The relative weight is a ratio scale that we can divide among them. For example, we can say that factor 2 is 2.27 (= 64.34/28.28) times more than factor 1, and factor 2 is 8.72 (= 64.34/7.38) times more than factor 3.

$$W = \frac{1}{3} \times \begin{matrix} 0.2381 & + & 0.2258 & + & 0.3846 & 0.2828 \\ 0.7143 & + & 0.6774 & + & 0.5385 & = 0.6434 \\ 0.0476 & + & 0.0968 & + & 0.0769 & 0.0738 \end{matrix}$$

The consistency of the n-order matrix is assessed in step 5. This method relies on subjective comparisons, and because of the method's high level of redundancy, the AHP accepts inconsistencies. Answers to comparisons may be re-examined if this consistency index falls short of the necessary threshold. The consistency index abbreviated CI, is determined by.

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{2}$$

Where;

$$\lambda_{max} = \frac{21}{5} (0.2828) + \frac{31}{21} (0.6434) + 13 (0.0738) = 3.0967 \tag{3}$$

So;

$$CI = \frac{\lambda_{max} - n}{n - 1} = \frac{3.0967 - 3}{2} = 0.0484 \tag{4}$$

Where λ_{max} is the maximum eigenvalue of the judgment, This CI can be contrasted with that of a random matrix, RI, where max is the judgment matrix's maximum eigenvalue. The consistency ratio, abbreviated CR, is the resultant ratio,

CI/RI. According to Saaty [5], the value of CR ought to be less than 0.1. Now that we are aware of the consistency index, how do we apply it? Prof. Saaty [7] once more suggested that we use this index by contrasting it with the proper one. The Random Consistency Index (RCI) is the proper Consistency Index (RI).

Table 6: Random Consistency Index (Ri)

N	1	2	3	4	5	6	7	8	9	10
R	0	0	0.5	0.	1.1	1.2	1.3	1.4	1.4	1.4
I			8	9	2	4	2	1	5	9

Then, used the Consistency Ratio formula, which is the comparison between CI and RI.

$$CR = \frac{CI}{RI} \quad (5)$$

If the value of the Consistency Ratio is smaller or equal to 10%, the inconsistency is acceptable. Subjective judgment is problematic if the Consistency Ratio is more excellent than 10%.

For our previous example, we have $CI = 0.0484$, and RI for $n = 3$ is 0.58 , then we have.

$$CR = CI/RI = 0.0484/0.58 = 8.3\% < 10\%$$

Thus, subjective evaluation of the factor is consistent.

2.7. Analytical Hierarchy Process (AHP) Software

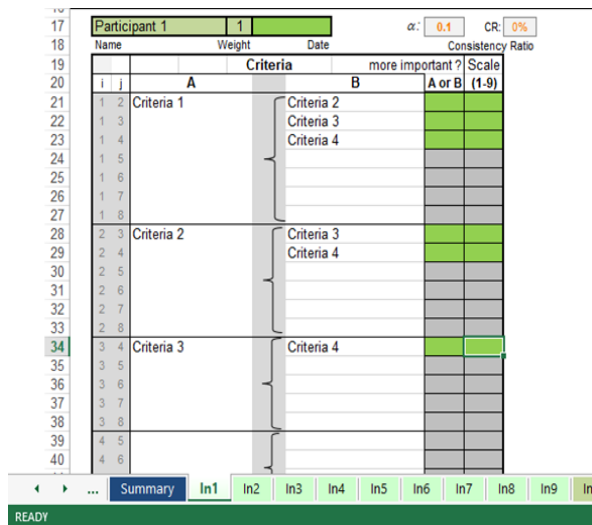
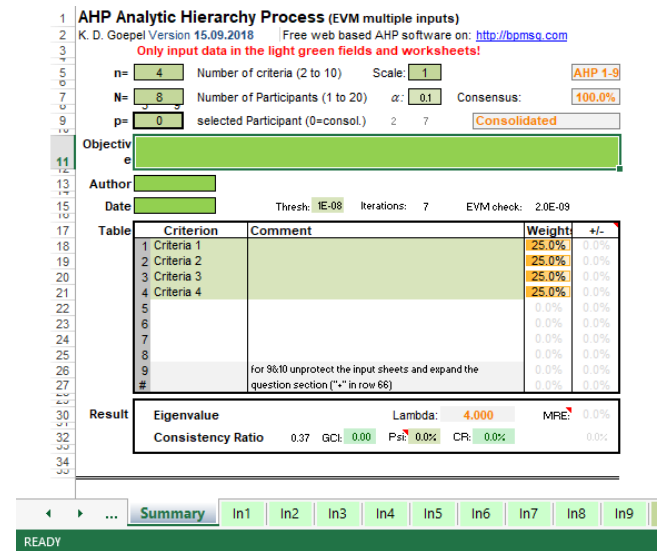


Figure 4: Example of Criteria AHP

The figure above shows an example of criteria in the analytic hierarchy process. From this figure, the questionnaire will be distributed to the expert, and the criteria are based on the first objective's achievement. The expert will choose the criteria or element of resilience using the scale provided in the questionnaire. The respondents who need to answer the questionnaire from this research are from the operational and safety departments. The respondents with expertise from the functional department are the general manager, senior manager, manager, and senior executive, two from the executive level and two from the non-executive

group. The other respondent is from the safety department and pilotage.

Figure 5: Example of The Result From Ahp Software



From this figure, we must key in the information based on the research. The information that we need to key in which is:

n = number of the criteria

N = number of participants or respondents

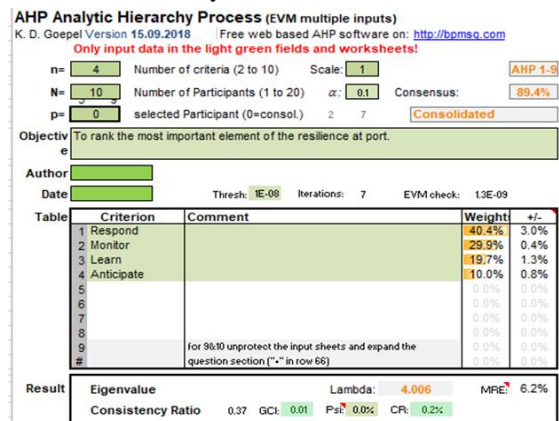
Objective = objective that needs to be achieved by using this AHP software

After we key in the data from the questionnaire, we will get the result, which is the weight and consistency ratio. If the value of the consistency ratio is smaller than or equal to 10%, the inconsistency is acceptable. If the consistency ratio is greater than 10%, there is a problem with subjective judgment [8].

3. Result and Discussion

3.1. The overall ranking of elements and sub-element of Resilience (Main Element Analysis)

It concludes that the Respond element ranked more highly than others, followed by the Monitor, Learn, and Anticipate



elements of Resilience. The value of the consistency ratio is 0.2% which is below 1%; hence the data is valid.

Figure 6: Summary of all ten respondents on the main element of Resilience

Table 7: Rating of each main criterion and sub-criteria are used to calculate or determine the ranking of the most critical element of Resilience

Criteria	Calculation											
Main criteria	Matrix										normalized principal Eigenvector $\begin{pmatrix} 40.42\% \\ 29.87\% \\ 19.73\% \\ 9.98\% \end{pmatrix}$	
		Respond	Monitor	Learn	Anticipate	0	0	0	0	0		0
	Respond	1	13/8	22/9	32/3	-	-	-	-	-		-
	Monitor	2	3/4	1	11/2	3	-	-	-	-		-
	Learn	3	4/9	2/3	1	21/7	-	-	-	-		-
	Anticipate	4	1/4	1/3	1/2	1	-	-	-	-		-
	Convert the fraction into decimal:											
		1.000	1.375	2.222	3.667	1.00	1.38	2.22	3.67			
		0.750	1.000	1.500	3.000	0.75	1.00	1.50	3.00			
		0.444	0.667	1.000	2.143	0.44	0.67	1.00	2.14			
	0.250	0.333	0.500	1.000	0.25	0.50	0.50	1.00				
a)												
$(1.000 \times 1.000) + (1.375 \times 0.750) + (2.222 \times 0.444) + (3.667 \times 0.250) = 3.935$												
$(1.000 \times 1.375) + (1.375 \times 1.000) + (2.222 \times 0.667) + (3.667 \times 0.333) = 5.453$												
$(1.000 \times 2.222) + (1.375 \times 1.500) + (2.222 \times 1.000) + (3.667 \times 0.500) = 8.340$												
$(1.000 \times 3.677) + (1.375 \times 3.000) + (2.222 \times 2.143) + (3.667 \times 1.000) = 16.230$												
b)												
$(0.750 \times 1.000) + (1.000 \times 0.750) + (1.500 \times 0.444) + (3.000 \times 0.250) = 2.916$												
$(0.750 \times 1.375) + (1.000 \times 1.000) + (1.500 \times 0.667) + (3.000 \times 0.333) = 4.031$												
$(0.750 \times 2.222) + (1.000 \times 1.500) + (1.500 \times 1.000) + (3.00 \times 0.500) = 6.167$												
$(0.750 \times 3.667) + (1.000 \times 3.000) + (1.500 \times 2.143) + (3.00 \times 1.000) = 11.965$												
c)												
$(0.444 \times 1.000) + (0.667 \times 0.750) + (1.000 \times 0.444) + (2.143 \times 0.250) = 1.924$												
$(0.444 \times 1.375) + (0.667 \times 1.000) + (1.000 \times 0.667) + (2.143 \times 0.333) = 2.658$												
$(0.444 \times 2.222) + (0.667 \times 1.500) + (1.000 \times 1.000) + (2.143 \times 0.500) = 4.059$												

$$(0.444 \times 3.667) + (0.667 \times 3.000) + (1.000 \times 2.143) + (2.143 \times 1.000) = 7.915$$

d)

$$(0.250 \times 1.000) + (0.333 \times 0.750) + (0.500 \times 0.444) + (1.000 \times 0.250) = 0.972$$

$$(0.250 \times 1.375) + (0.333 \times 1.000) + (0.500 \times 0.667) + (1.000 \times 0.333) = 1.343$$

$$(0.250 \times 2.222) + (0.333 \times 1.500) + (0.500 \times 1.000) + (1.000 \times 0.500) = 2.055$$

$$(0.250 \times 3.667) + (0.333 \times 3.000) + (0.500 \times 2.143) + (1.000 \times 1.000) = 3.987$$

Result in this:

$$\begin{bmatrix} 3.935 & 5.453 & 8.340 & 16.230 \\ 2.916 & 4.031 & 6.167 & 11.965 \\ 1.924 & 2.658 & 4.059 & 7.915 \\ 0.972 & 1.343 & 2.055 & 3.987 \end{bmatrix}$$

Now, compute the first Eigenvector, first sum the rows,

$$\begin{bmatrix} 3.935 & + & 5.453 & + & 8.340 & + & 16.230 \\ 2.916 & + & 4.031 & + & 6.167 & + & 11.965 \\ 1.924 & + & 2.658 & + & 4.059 & + & 7.915 \\ 0.972 & + & 1.343 & + & 2.055 & + & 3.997 \end{bmatrix}$$

Total for:

- First column = 33.958
- Second column = 25.079
- Third column = 16.556
- Fourth column = 8.367

Sum all the total columns = 83.960

Normalized by dividing the sum of the total column:

$$1) 33.958 \div 83.960 = 0.404$$

$$2) 25.079 \div 83.960 = 0.299$$

$$3) 16.556 \div 83.960 = 0.197$$

$$4) 8.367 \div 83.960 = 0.100$$

$$= 1.000$$

$$\begin{bmatrix} 0.404 \\ 0.299 \\ 0.197 \\ 0.100 \end{bmatrix}$$



1st Eigenvector

This process must be iterated until the eigenvector solution does not change from the earlier iteration.

Again, square the matrix:

$$\begin{bmatrix} 3.935 & 5.453 & 8.340 & 16.230 \\ 2.916 & 4.031 & 6.167 & 11.965 \\ 1.924 & 2.658 & 4.059 & 7.915 \\ 0.972 & 1.343 & 2.055 & 3.987 \end{bmatrix}$$

x

$$\begin{bmatrix} 3.935 & 5.453 & 8.340 & 16.230 \\ 2.916 & 4.031 & 6.167 & 11.965 \\ 1.924 & 2.658 & 4.059 & 7.915 \\ 0.972 & 1.343 & 2.055 & 3.987 \end{bmatrix}$$

The result:

$$\begin{bmatrix} 63.207 & 87.403 & 133.651 & 259.830 \\ 46.724 & 64.611 & 98.799 & 192.074 \\ 30.825 & 42.624 & 65.179 & 126.714 \\ 15.570 & 21.531 & 32.923 & 64.006 \end{bmatrix}$$

Again, compute the Eigenvector,

Total for:

- First column = 544.091
- Second column = 402.208
- Third column = 265.342
- Fourth column = 134.030

Sum all the total columns = 1345.671

Normalized by dividing the sum of the total column:

- 1) $544.091 \div 1345.671 = 0.404$
- 2) $402.208 \div 1345.671 = 0.299$
- 3) $265.342 \div 1345.671 = 0.197$

4) $134.030 \div 1345.671 = 0.100$
 $\quad\quad\quad = 1.000$

$$\begin{bmatrix} 0.404 \\ 0.299 \\ 0.197 \\ 0.100 \end{bmatrix}$$

↑

2nd Eigenvector

Respond	= 0.404	➔	1 st rank
Monitor	= 0.299	➔	2 nd rank
Learn	= 0.197	➔	3 rd rank
Anticipate	= 0.100	➔	4 th rank

From the results in the table above, the rating of each main criterion and sub-criteria is used to calculate or determine the ranking of the most important element of resilience. The way to identify the priority level of the element is by using the following:

Step 1:

Global weight = (Main Element Weight) x (Local weight)

Step 2

The value of the global weight measures the priority level of the sub-element. A higher number of international significances means a higher ranking at the priority level of the sub-element. All the opinions of 10 respondents were used for a pairwise comparison for each of the sub-criteria elements that can cause the most crucial aspect of resilience.

Table 8: The Comparative Analysis (Pair Wise Comparison) of the AHP Methods

	Element	Sub-element	Local weight	Global weight	The priority level of sub-element
Resilience	Respond (0.404)	Readiness for Action	0.480	0.1939	1
		Operator Reliability	0.242	0.0978	5
		Facilities Reliability	0.278	0.1123	4
	Monitor (0.299)	Accident	0.391	0.1169	3
		Natural Factor	0.196	0.0586	8
		System Malfunction	0.413	0.1235	2
	Learn (0.197)	Training	0.455	0.0896	6
		Documentation	0.356	0.0701	7
		Organizational	0.189	0.0372	10
	Anticipate (0.100)	Awareness	0.330	0.0330	11
		Implementation	0.463	0.0463	9
		Strategy	0.207	0.0207	12

Table 9: Normalized Value in Percentage of Main Element

Main element	Percentage (%)	Rank
Respond	40.4	1
Monitor	29.9	2

Learn	19.7	3
Anticipate	10.0	4

Table 10: Normalized Value in Percentage of Sub-element

Element	Sub-element	Percentage (%)	Rank
Respond	Readiness for Action	47.8	1
	Operator Reliability	25.5	5
	Facilities Reliability	26.7	4
Monitor	Accident	38.3	3
	Natural Factor	19.6	8
	System Malfunction	42.1	2
Learn	Training	45.0	6
	Documentation	35.5	7
	Organizational	19.5	10
Anticipate	Awareness	33.5	11
	Implementation	46.1	9
	Strategy	20.4	12

4. Recommendation for Future Research

The research that had been done found that the anticipated element has the lowest ranking among the other elements. The main expectation element consists of awareness, implementation, and a strategy sub-element. Upon gathering feedback from the respondents from the ports, these elements should take the matter as seriously as the others. The following sections should take some action, which is:

- i. Planning Documents for Hazards and Safety
- ii. Hazard Assessment Infrastructure and Assets
- iii. Continuity of Operational Planning for Infrastructure and Facilities
- iv. Emergency Operations Location
- v. Critical Record

5. Conclusion

In conclusion, all the research objectives, which were to identify the elements of resilience, rank the elements of resilience at port according to their importance, and recommend the best solution to improve resilience in Consortium Port Kemaman for this study, have been achieved, so the study has reached its conclusion. Based on the results obtained from interviews and questionnaires, the researcher can investigate the most critical elements of resilience at Consortium Pelabuhan Kemaman. From this research, the researcher found which part is the most important at Consortium Pelabuhan Kemaman. The most critical element at Consortium Pelabuhan Kemaman was the response. The respondents chiefly agreed upon this element after the questionnaire and interview session. The lowest

ranking of the element was anticipated, and this is because Consortium Pelabuhan Kemaman has the lowest percentages of awareness, implementation, and strategy. The previous chapter recommended improving the resilience at Consortium Pelabuhan Kemaman. Finally, all the recommendations were made to enhance the resilience level at the Consortium Pelabuhan Kemaman, and all the objectives were achieved while conducting this research.

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Competing Interest

The author declares that there are no conflicts of interest regarding the publication of this paper.

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REFERENCES

- [1] [1] B. H. N. Razafindrabe, G. A. Parvin, A. Surjan, Y. Takeuchi, and R. Shaw, "Climate Disaster Resilience: Focus on Coastal Urban Cities in Asia," Asian Journal of Environment and Disaster Management (AJEDM) - Focusing

on Pro-Active Risk Reduction in Asia, vol. 01, no. 01, pp. 101, 2009. <https://doi.org/10.3850/s179392402009000088>

- [2] [2] S. Pant, A. Kumar, M. Ram, Y. Klochkov, and H. K. Sharma, "Consistency Indices in Analytic Hierarchy Process: A Review," *Mathematics*, vol. 10, no. 8, pp. 1-15, 2022. <https://doi.org/10.3390/math10081206>
- [3] [3] D. R. Shaw, A. Grainger, and K. Achuthan, "Multi-level port resilience planning in the UK: How can information sharing be made easier?," *Technological Forecasting and Social Change*, vol. 121, pp. 126-138, 2017. <https://doi.org/10.1016/j.techfore.2016.10.065>
- [4] [4] T. L. Saaty, "How to decide: The analytic hierarchy process," *European Journal of Operational Research*, vol. 48, no. 1, 1980. [https://doi.org/10.1016/0377-2217\(90\)90057-I](https://doi.org/10.1016/0377-2217(90)90057-I)
- [5] [5] T. L. Saaty and L. G. Vargas, "Models, Methods, Concepts and Applications of the Analytic Hierarchy Process," Boston: Kluwer Academic Publishers, 2000.
- [6] [6] S. Pant, A. Kumar, M. Ram, Y. Klochkov, and H. Sharma, "Consistency Indices in Analytic Hierarchy Process: A Review," *Mathematics*, vol. 10, pp. 1206, 2022. <https://doi.org/10.3390/math10081206>.
- [7] [7] K. Nazery, "China's port development and shipping competition in East Asia," *The Asia-Pacific Journal: Japan Focus*, May 6, 2006. Retrieved March 15, 2023, from <https://apjif.org/-Nazery-Khalid/1649/article.html>.