Prioritising Optimal Actions in Pandemic Management: An Analytical Hierarchical Process Approach

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Article History: Received 7 February 2024; Revised 26 March 2024;
Accepted 13 June 2024

Abstract

The stage of the decision-making process is the most complex one, and it is necessary to emphasize a variety of aspects to have a positive effect on the stage that comes after it. In order to resolve a problem or make an evaluation of something, decisions need to be made by the decision maker, who should be free from any bias or outside influence. This study concentrates on the operation in North Port, Port Klang, Malaysia, which is the main pulse of the Malaysian economy, aiming to deal with the pandemic by making the most accurate decisions possible systematically for those decisions to be able to deal with the pandemic that has struck. It has been determined which categories contribute to the actions that need to be taken to deal with the pandemic at the port, and all these categories have been enumerated so that specialists can evaluate which categories are the most influential. For data analysis, the Analytical Hierarchical Process (AHP) method is utilised, and the findings also assist decision-makers in making the appropriate choices. Consequently, based on study's findings, it was discovered that the primary criterion that needs to be prioritized in North Port's response to the pandemic is health and safety, which received a score of 20%, followed by technology (18%), PPE (18%), MCO (12%), wedges (9%), manpower (8%), damage (6%), origin country (5%) and lastly delay time (5%). Therefore, the port side may use the possibility presented by this study to systematically decide any problem that may arise at the management level.

Keywords: Marine Risk Assessment, Analytical Hierarchical Process (AHP), Port Management

1.0 Introduction

Making decisions is a crucial task because every decision will have repercussions for multiple parties. Therefore, the decision-maker must tread cautiously when resolving problems that arise. The decision-makers must generate, catalogue, and assess each alternative course of action. This phase is sometimes straightforward but difficult to implement. Alternative actions

should be thoughtful and profound.

According to the Vickers's study, decision-making typically consists of four (4) phases [1], the first of which is acquiring accurate, valid, and reliable information. This information can obtain from interviews, studies, and reports, among other sources. Typically, when making a decision, a great deal of information can obtain. The second step is to make a selection of only relevant and essential information. Not all information is useful and capable of aiding in achieving the intended outcome. Only pertinent information will play a role in influencing a course of action and producing diverse results.

The third phase involves evaluating the repercussions of each alternative. This phase necessitates an in-depth discussion among individuals with relevant expertise, knowledge, and experience. Finally, the final phase necessitates the decision-maker to choose one of the alternative actions that will result in something or the desired outcome. Most importantly, the selection must align with the objectives and goals of the organization.

Typically, this decision will made based on the outcomes of discussions and the consensus of all parties with a stake in the outcome. Therefore, this study employs the Analytical Hierarchy Process (AHP) to assist each stakeholder in making accurate and efficient decisions that are not influenced by the surrounding environment.

The analytical hierarchy process (AHP) is a systematic process centred on mathematics and psychology for organizing and analysing complex decisions [2]. Thomas L. Saaty created it in the 1970s [3]. The AHP method was developed after understanding the structure of a problem and the actual constraints that organizations face when attempting to solve it.

The primary goal of this research is to make the best decision possible so that the North Port can arrange the first step strategy for dealing with the pandemic situation at the port. Based on the findings of this research, the port side can organize steps based on the importance assigned. It is concentrated in North Port, Malaysia, which is the focal point for traders from all over the nation who are also affected by the pandemic [4]. Because the sea route does not stop during the pandemic, no nation must break off the supply chain to guarantee human survival [5]. It would be beneficial if we deal with this pandemic issue at the beginning of the entrance to Malaysia by helping the North Port assess and make the correct decision so that the pandemic can be contained

2.0 Methodology

As shown in Figure 1, there are four steps to completing this research successfully [2]. The first step is to create a hierarchical structure, followed by pairwise comparison, a calculation of criteria weight, and a check of the consistency ratio. This approach is also used in the research of identifying risks in railways [6], ensuring the primary energy supply in mining [7], and

selecting material suppliers in the industry [8], among other things [9] – [11]. For this research, we use the same approach as previous research to assist the port in determining the first and best step in dealing with the pandemic issues in North Port.

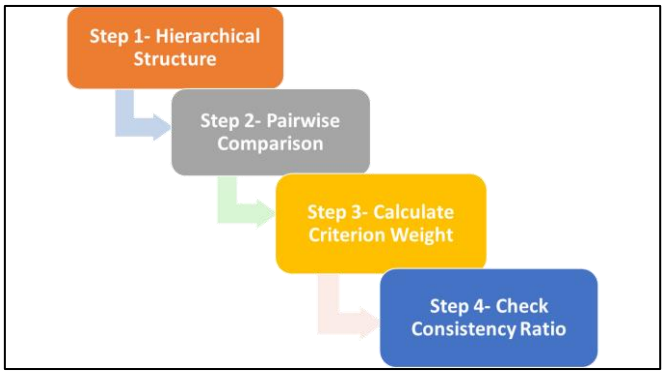

Figure 1: Four steps of AHP approach [12]

2.1 Hierarchical Structure

The most important part of this AHP process is the first step [13]. Researchers must start with the goal of the study to build a hierarchical structure [17]. The main goal of this study is to find the best decision to deal with problems caused by pandemics in ports.

With the AHP, a complicated decision model made by putting together a hierarchy of interconnected decision parts. Using AHP, items, parameters, and options are set up in a family tree in a way that shows their relationship to each other [15]. Using the mathematical process, the decision group is together. To deal with the subjectivity and ambiguity of the alternative selection process, numbers are used to represent words from a linguistic point of view. Based on this principle, the decision maker's attitude towards choice is use to come up with a clear overall value for each option.

Next, choose the criteria that have to do with the purpose of the study and add sub-criteria that support the main criteria. For this study, three major criteria were set up:

i. Workers
ii. Standard Operation of Procedure (SOP)
iii. Goods of merchandise

The criteria were set based on conversations over the phone with the port administration and a review of the literature by looking at past studies on AHP. Then, for each group of criteria, write down the sub-criteria that go with it. Figure 2 shows how this study's hierarchy works as a whole. Meanwhile, the line in the picture shows how each part of the hierarchical structure depends on the other parts.

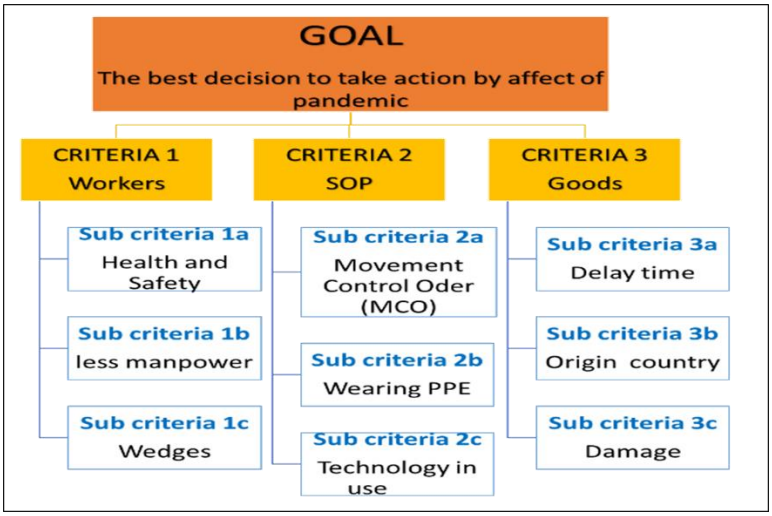

Figure 2: Hierarchal structure of pandemic AHP

2.2 Pairwise Comparison

Pairwise comparison is any method of contrasting criteria in pairs to determine which criterion is preferable, has a greater quantity of a quantitative characteristic, or if the two entities are identical. These pairwise comparisons are typically performed for no more than seven significant factors in an analysis [16]. Also known as "expert choice" [17]. In this research, a total of ten North Port management experts have been selected to serve as respondent experts.

Figure 3 depicts a pairwise comparison table as explained in the study of [18] that is connected to Table 1, which depicts the relative importance of left and right criteria ranging from equally essential to extremely important. For example, refer to Figure 3 line 1 pairwise between worker and SOP, if the first expert selects a value of 5 for the left criteria (worker), this indicates that the left criteria are strongly important (see Table 1) than the right criteria (SOP).

Each criterion and sub-criterion must be compared pairwise within the identical clusters. Criteria within criteria, sub-criteria 1 within sub-criteria 1a, 1b, and 1c, as shown in Figures 3 and Figure 4; then repeat for sub-criteria 2 and 3.

Worker	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SOP
Worker	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Goods
SOP	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Goods

Figure 3: Main criteria

Sub criteria 1																	
Health & Safety	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Manpower
Health & Safety	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Wedges
Manpower	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Wedges
Sub criteria 2																	
MCO	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	PPE
MCO	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technology
PPE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technology
Sub criteria 3																	
Delay Time	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Origin Country
Delay Time	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Damage
Origin Country	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Damage

Figure 4: Sub-criteria

Table 1: Indicator of relative important [19]

Relative Important	*Definition*	*Explanation*
1	Equal Importance	Two activities equal to objective
3	Weak Importance	Experience and judgement strongly favour one activity over another
5	Strong Importance	Experience and judgement strongly favour one activity over another
7	Demonstrate Importance	One activity is strongly favoured and demonstrated in practice
9	Extreme Importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values	When compromise is needed between two adjacent judgments

After collecting the scores for all pairwise comparisons, the weights are calculated separately based on the previously formed pairwise comparison group. As shown in Figure 5, is to calculate the weights for the criterion, followed by the weights for the sub-criteria to obtain the priorities. The weight is determined using the method shown in Equation 1. Tables and Microsoft Excel have been used to make the calculations more accurate and easier to do.

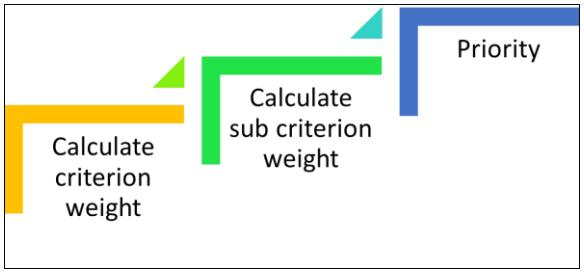

Figure 5: Steps for priory calculation

$$\boldsymbol{Weightage} = \frac{1}{\boldsymbol{No.of\ comparison}} \times \left(\frac{\boldsymbol{Rating_{c\,1}}}{\boldsymbol{\Sigma Rating\ c1}} + \frac{\boldsymbol{Rating_{c\,2}}}{\boldsymbol{Rating\ c2}} + \frac{\boldsymbol{Rating_{cn}}}{\boldsymbol{Rating\ cn}}\right) \quad (1)$$

Following the computation of the two weights, the order can be classify based on the previously computed weights. Priority was calculated using the method shown in equation 2 by multiplying weightage criteria by the weightage of sub-criteria. The formula was then simplified by research of Zaini [21] to make it simpler to comprehend, as shown in equation 3.

$$\boldsymbol{V(A_i) = \sum_{k=1}^{n} w_1 w_{k(1)} v(a_{ik})} \quad (2)$$

where,
$v(a_{ik})$ = value function
w_1 = criteria weightage of criteria associated with sub-criteria
$w_{k(1)}$ = criteria weightage of sub-criteria

$$Priorities = Criterion\ weightage\ of\ criteria \times Criterion\ weightage\ of\ subcriteria \quad (3)$$

Less than 0.1 is the reliable consistency ratio (CR) [23]. It is the transitivity concept in the weights of the criteria. If the CR is more than 0.1, the value is indicative of inconsistent judgment. Therefore, CR can be calculated by referring to formulas in Equation 4.

$$CR = \frac{\lambda_{max} - n}{RI\ (n-1)} \quad (4)$$

λ_{max} = *eigenvalue*
n = *number of criteria*
RI = *weight of random criteria*

The expert choice value is formed into a diagonal matrix. The eigenvalues are computed. The eigenvalue calculation can be performed directly or by using any available program. The values are then arranged in a table to simplify the computation, as shown in Table 2. Table 2 also demonstrates that the CR calculation result for each respondent is less than 0.1; demonstrating that the judgement received is consistent and that further analysis can be performed without uncertainty.

Table 2: Consistency ratio for criteria

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
Eigenvalue	3.47	3.62	3.37	3.30	3.19	3.05	3.30	3.30	3.30	3.70
n	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Eigenvalue * n	0.47	0.62	0.37	0.30	0.19	0.05	0.30	0.30	0.30	0.70
n-1	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CI	0.23	0.31	0.18	0.15	0.09	0.03	0.15	0.15	0.15	0.35
RI	6.50	6.50	4.50	3.00	1.37	1.22	6.20	6.17	6.20	6.13
CR	0.04	0.05	0.04	0.05	0.07	0.02	0.02	0.02	0.02	0.06

3.0 Results and Discussion

Prioritization findings from each specialist are summarised and averaged in Table 3. The health and safety priority at the North port ranks highest, at 19%, followed by damage criteria and MCO, each with a score of 18%. Figure 2 shows hierarchical structure that worker health and safety in-group of worker criteria, meanwhile damage in-group of standard operating procedure (SOP).

Considering these findings, the North Port can use the information in Figure 6 as a guide for putting labour safety first. It proves that the port authorities made the correct choice in how to deal with the pandemic. The "delay time" was rank last, with a score of 5%, indicating that it is not a top concern for employers.

Table 3: Priorities

Criteria	*E1*	*E2*	*E3*	*E4*	*E5*	*E6*	*E7*	*E8*	*E9*	*E10*	*Mean*
Health and safety	0.09	0.08	0.10	0.24	0.51	0.53	0.17	0.06	0.06	0.12	0.19
Technology	0.20	0.32	0.32	0.43	0.12	0.01	0.07	0.23	0.05	0.02	0.18
PPE	0.17	0.12	0.08	0.03	0.06	0.10	0.51	0.22	0.22	0.23	0.18
MCO	0.19	0.04	0.05	0.03	0.02	0.10	0.07	0.22	0.39	0.07	0.12
Wedges	0.09	0.06	0.10	0.02	0.11	0.04	0.02	0.17	0.17	0.15	0.09
Manpower	0.08	0.11	0.10	0.05	0.09	0.16	0.06	0.02	0.02	0.08	0.08
damage	0.06	0.09	0.17	0.06	0.03	0.00	0.06	0.01	0.01	0.11	0.06
Origin Country	0.06	0.09	0.05	0.06	0.03	0.01	0.01	0.05	0.06	0.11	0.05
Delay time	0.06	0.09	0.05	0.06	0.03	0.04	0.02	0.02	0.02	0.11	0.05

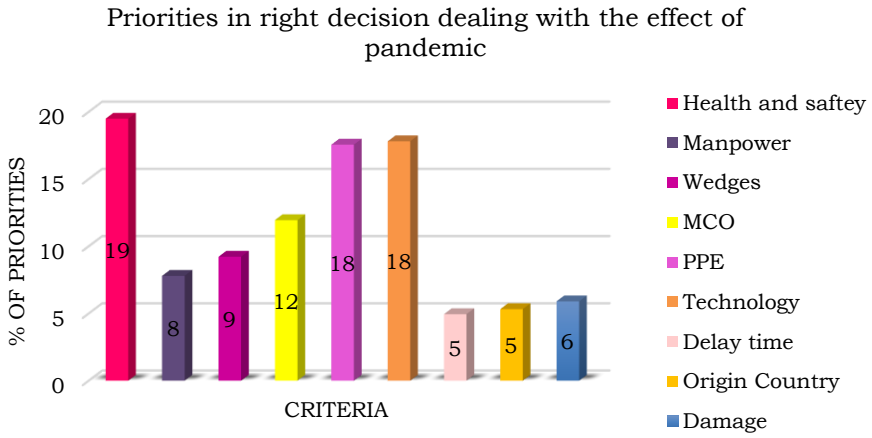

Figure 6: Priorities in the right decision dealing with the pandemic

4.0 Conclusion

Before conducting this study, most participants in a face-to-face discussion agreed that movement control order (MCO) is an essential requirement during a pandemic. As we all know, Malaysia will begin MCO on March 18, 2020, and continue until December 31, 2021 [25]. Nearly two years of MCO have

crippled numerous effects such as economic sectors [26], including education [27], transportation, and others [27]. We are also aware that the effect of the utilised MCO has pros and cons that generate income for one party and income loss for another. These decisions are made from the expert's perspective, but each will have its own bias and influence [28]. Through this investigation, any outcome is documented, and probability has been converted into a mathematical formula. The outcomes are more precise and facilitate fast decision-making.

Health and safety must be the primary consideration for North Port. Health and safety are a multidisciplinary discipline focusing on workers' safety, health, and welfare. The occupational safety and health programme aims to promote a safe and healthful workplace. In Malaysia, the Department of Occupational Safety and Health (JKKP) is responsible for assuring public and private sector workers' safety, health, and welfare [29]. JKKP enforces the Factories and Machinery Act of 1967 and the Occupational Safety and Health Act of 1994.

It also encompasses the safety of an employee who contracted an infectious disease. The employee should now take precedence over merchandise and high compensation. Prioritize the risk of the disease being contagious to other employees and determine what actions must be taken against the affected employees. Before the disease spreads, the port must provide all workers with guidelines for operating in a safe and healthy environment. Additionally, workers must have access to medical facilities and vaccinations before the disease spreads. For instance, if a patient's illness has been validated, he or she should be excused from work and quarantined in a designated location without returning home, increasing the risk of infectivity. In addition, this criterion protects the welfare of employees and their families in terms of leave, medical benefits, and the absence of salary deductions during quarantine.

Here, it is evident that the middle criterion is wedges (9%), and it is evident that a high salary is pointless if the body is sick. Health cannot be purchased with money, but many employers care more about profit than their employees' health and safety, as they can fire and engage new workers without considering the affected workers.

In addition, the second important criterion is technology with a score of 18%. Continuity from the MCO has evolved due to various advanced technologies, ensuring that all relationships and work affairs can continue uninterrupted by the MCO. It demonstrates how the speed of modern technology aids in coping with the pandemic at the port. As we now know, all meetings can be conducted online rather than in person, and all work can be completed on a virtual platform rather than in person[30], and technology can identify unhealthy workers at work without permission. At the same time, this pandemic helps everyone by renewing how we work towards IR4.0 [31], [32].

The result of AHP can be visualized and analysed deeper by integrating with GIS, as we know GIS is a magic tool that can be stored, analysed, manipulated and design as mentioned in the study of heritage databases [33]. Otherwise, the data also can gather to perform a forecast using neural network analysis [34] and predict the future risk of pandemic at Northport.

The port management can use the results of this study to assist in the future management of infectious disease risk. AHP also can be utilised in various situations involving extreme decision selection. In addition, this study can assist the North Port in developing a framework that facilitates the evaluation of every decision made by decision-makers. It is not restricted to North Port and can be utilised extensively in ports nationwide.

Acknowledgement
Both the Ministry of Higher Education (MOHE) and the Hadiah Latihan Persekutuan (HLP) provided funding for this study through the Fundamental Research Grant System (FRGS/1/2021/STG08/UTHM/03/2). The authors would like to extend their deepest gratitude to the Port Klang Authority for their continuous encouragement, which was essential to this research project investigating the marine disciplines' past, present, and potential future.

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