Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 12, December-2021

Establishing a Priority Scale for Passenger Ship Terminal Renovations to Improve Services using AHP Method

Johanna Matakupan
Department of Sea Transportation
Universitas Pattimura
Maluku, Indonesia

Gerard Richard Latuhihin
Department of Naval Architech,
Universitas Pattimura
Maluku, Indonesia

Pieter Thomas Berhitu
Department of Regional and Urban Planning,
Universitas Pattimura
Maluku, Indonesia

***Abstract*— The port is one of the transportation nodes in the logistics system that has a strategic role. However, the current condition of ports in Indonesia is still far from expected, causing port services to not provide optimal support in supporting the National Logistics System. Therefore, it is necessary to plan and control ports to support the National Logistics System. This research studies the selection of priority scales for improving port facilities at Tulehu Seaport, Maluku, using the AHP (Analytical Hierarchy Process) method to improve passenger port services at the Passenger Terminal. The analysis criteria are divided into 3, namely: Mobility, Service, and Room. AHP advises that effective spatial planning is a top priority to be implemented. The results of this study can be considered by the government/passenger terminal manager to take appropriate actions according to the passengers' needs**

Keywords—AHP, Passenger Terminal, Decision, Tulehu Seaport, Priority Scale

I. INTRODUCTION

Sea transportation serves to serve the mobility of people, goods, and services that connect economic activities between islands and international relations, while air transportation serves to serve fast transportation between islands and between countries for people, goods and services as well as connecting isolated areas, remote areas, and border areas that have not been connected by other modes of transportation [1].

Tulehu Seaport serves domestic shipping with a large number of passengers. The location of Tulehu Port is very strategic for connecting islands in Maluku Province, see Figure 1. The Indonesian government has a national strategic program, Maluku as the "National Fish Barn"[2][3]. As the impact of this policy, the Maluku local government must prepare supporting facilities to accelerate the national strategic plan, namely the Tulehu Sea Port[4].

Tulehu Harbor is a very busy port, especially before Christmas. Passengers at Tulehu Harbor, Salahutu District, Ambon Island on D - 1 Christmas celebrations exploded. As a result, officers, both at the airport and the police at the port, were observed to be overwhelmed with regulating inter-island departure activities. Monitoring, Saturday (24/12), the number of passengers at the Tulehu port was booming because it was used for crossings to Haruku Island, Saparua, Nusalaut and Amahai Port, Seram Island, Central Maluku Regency. Airport officers intensively monitor the loading capacity of fast boats, especially those operating to the ports of Amahai and Haria, Saparua island[5].

Figure 1 Tulehu Seaport Location

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 12, December-2021

Figure 2 The embarkation process at the port of Tulehu, Central Maluku Regency, was observed to be very crowded[5]

The number of passengers has increased every year, as shown in Table 1. This is presumably due to an increase in public interest in using fast boats. In addition, the phenomenon of long school holidays and holidays is the cause of people traveling by ship. On the other hand, the limited number of fast boats means that many passengers, be it the public or domestic and foreign tourists, cannot be transported every day. The Maluku Regional Government plans to add a fleet of fast boats to serve the increasing number of passengers.

Table 1 Data recapitulation of visits and loading and unloading of Tulehu Port passengers in 2015 – 2019 [6]

Year	Ship Call	Passanger	
		Unloading	Loading
2015	2155	146082	123756
2016	1952	150412	120736
2017	1873	147461	105614
2018	2205	126674	125011
2019	2175	147547	184363

In this research, comprehensive research will be carried out related to determining the priority scale for the renovation of the passenger terminal, including: mobility, services and rooms using the AHP method. With the existing data, the development of the Tulehu port, Maluku will be carried out in order to meet the feasibility of the passenger terminal to operate properly.

II. LITERATURE STUDY

A. *Tulehu Seaport, Maluku*

Harbor is everything related to the implementation of port functions to support the smooth, security and orderly flow of ship, passenger and/or goods traffic, sailing safety and security, intra and/or intermodal transfer sites and to encourage the national and regional economy while still paying attention to regional layout

Tulehu Harbor is located in Salahutu District, Central Maluku, Maluku Province, Indonesia, and is the gateway for residents from the islands of Saparua, Seram, Haruku, Nusalaut and other islands to Ambon City. Tulehu Harbor has an area of about 3 ha [8].

Figure 3 Tulehu Sea Port

There are three fleets of ships that serve inter-island sea transportation based at the Tulehu port, namely speed boats, wooden boats and large fast boats over 100GT. Speed boats are small vessels (under 7 GT) made of fiber, with a 40 HP engine. Speed boat is a means of inter-island sea transportation by residents of the Lease Islands which has been going on since the 1980s, covering Saparua Island, Haruku Island and Nusa Laut Island. Compared to wooden boats, speed boats are more suitable for use as a means of transportation because in addition to faster travel times, they also pay attention to aspects of sailing safety. When compared to large fast boats, speed boats have a more flexible departure schedule, because they do not have a fixed departure schedule. At any time residents can use a speed boat with a maximum passenger capacity of 5-6 people[7].

Figure 4 Several Ships dock at Tulehu Seaport

B. *Analytical Hierarchy Process (AHP)*

The Analytical Hierarchy Process (AHP) is a concept, tool, technique or method in making and making decisions for complex, unstructured and multi-attribute problems by ranking the available decision alternatives and then choosing the best one with the criteria set. determined by a numeric value.

AHP is a decision support model developed by Thomas L. Saati a mathematician from the University of Pittsburg, United States in the 1970s[9]. This decision support model will describe a complex multi-factor or multi-criteria problem into a hierarchy. AHP is widely used in decisions for many criteria, planning, resource allocation and prioritization of the strategies that players have in conflict situations. With AHP, a complex problem can be broken down into groups which are then arranged into a hierarchical form so that the problem will appear more structured and systematic.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 12, December-2021

Mulyono [10] the principles used in solving problems with the AHP method are as follows:

1. *Decomposition*
   This principle is the solution of complete problems into their elements to form a hierarchical decision-making process where each element or elements are interconnected. If you want to get accurate results, solving is done on the elements until it is impossible to do further solutions so that several levels of the problem are obtained. The decision hierarchy structure can be said to be complete and incomplete. A hierarchy is called complete if all elements at one level correspond to all elements at the next level, while an incomplete decision hierarchy is the opposite of complete. The form of the decomposition structure is: the first level: decision objectives, the second level: the criteria and the third level: the alternatives
2. *Comparative Judgement*
   This principle provides an assessment of the relative importance of two elements at a given level in relation to the level above it. This assessment is the essence of using the AHP method. This assessment can be presented in the form of a matrix called a pairwise comparison matrix, which is a pairwise comparison matrix containing the preference levels of several alternatives for the criteria.
3. *Synthesis of Priority*
   In this principle, it presents a pairwise comparison matrix which is then searched for the eigenvectors to get local priority. Because the pairwise comparison matrix is present at each level, to get the global priority, we can synthesize between the local priorities
4. *Logical Consistency*
   is the most important characteristic. This can be achieved by aggregating all the eigenvectors obtained from the hierarchical levels and then obtaining a weighted composite vector that results in the decision-making sequence.

III. METHOD

This study uses a combination of qualitative and quantitative methods. The qualitative method is used when measuring the relative between the factors that affect the passing grade/passing threshold and the checklist from primary data. While quantitative methods are used to carry out hierarchical rankings and calculate the weighting of each criterion. A combination of qualitative and quantitative methods was used when validating the research results by comparing the results of the AHP analysis and the results of interviews with stakeholders at the research site, among others:

Stage I: This stage is the preliminary stage to formulate the criteria and sub-criteria of the factors needed to carry out renovation/improvement of the Class II Tulehu port obtained from primary data (questionnaires and interviews)

Stage II: This stage is the stage of formulating the dominant criteria and sub-criteria formed from the AHP method to obtain the factors that determine the need for renovation/improvement of the Tulehu Class II port

Stage III: The AHP analysis stage is the analysis of primary data results from class II Tulehu port service users. Furthermore , the AHP method is used to determine the priority scale of decision making from the available data.

AHP Analysis of Tulehu Class II Passenger Port Terminal Facility Needs based on a study of social and economic aspects as shown in Figure 5.

The AHP Hierarchy Model in this study consists of:
1. Criteria
2. Sub-Criteria
3. Alternative

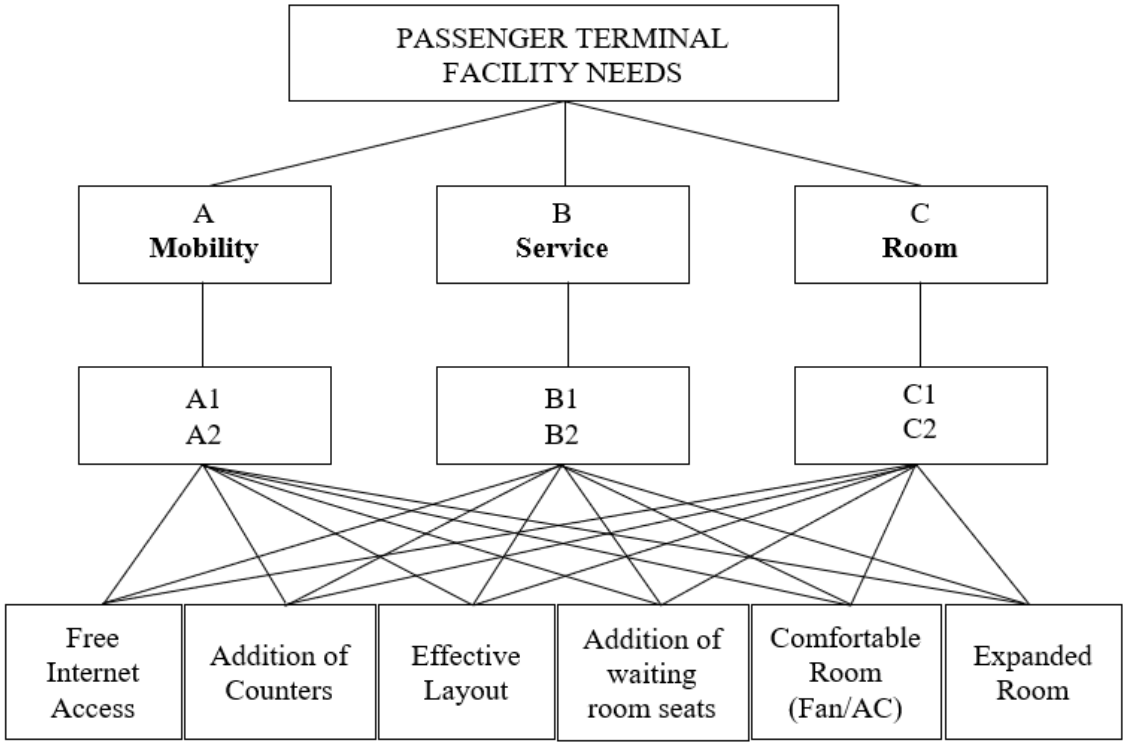
Criteria and Sub-Criteria for the Need for Class II Tulehu Passenger Terminal Port Facilities consist of:
1. Mobility Criteria
Which of the following Mobility sub-criteria is the most important in Fulfilling Passenger Terminal Facility Needs?
A1. Passenger Mobility in comfort
A2. Passenger Mobility effectively

2. Service Criteria
Which of the following service sub-criteria is the most important in Fulfilling Passenger Terminal Facility Needs?.
B1. Service with online check-in
B2. Service by Checking in manually

3. Room Criteria
Which of the following room sub-criteria is the most important in Fulfilling Passenger Terminal Facility Needs?
C1. The room needs to be expanded
C2. The room needs a spatial change

Furthermore, the steps/alternatives that need to be taken to meet the needs of Tulehu Class II Passenger Terminal Port Facilities are 6 activities that need to be carried out, including:
1. Providing Internet Access
2. Adding Counters
3. Doing Effective Spatial Planning
4. Additional Passenger Seats
5. Provide a comfortable/cool room by installing a fan/AC
6. Expanded room

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 12, December-2021



Information: A is Criteria ; A1, B1, C1 are sub-criteria

Figure 5 AHP Process Hierarchy Model Design

The steps and process of Process Hierarchy Analysis (AHP) are as follows:

1. Defining the problem and setting goals. If AHP is used to select alternatives or develop alternative priorities, at this stage the development of alternatives is carried out.
2. Arrange problems into a hierarchy so that complex problems can be viewed from a detailed and measurable perspective.
3. Prioritization for each problem element in the hierarchy. This process generates the weight or contribution of elements to the achievement of goals so that the element with the highest weight has priority for handling. Priority is generated from a pairwise comparison matrix between all elements at the same hierarchical level.
4. Conducting consistency testing on comparisons between elements obtained at each level of the hierarchy.

IV. RESULT AND DISCUSSION

This principle means making judgments about the relative importance of two elements at a given level in relation to the level above it. The results of this assessment are more easily presented in the form of a pairwise comparison matrix.

A. Criteria – Sub Criteria

The results of the Questionnaire that have been distributed to Class II Tulehu Port users are shown in Table 2-3

Table 2 Quantity Criteria Results

	Mobility	Service	Room
Mobility	1.00	0.20	0.20
Service	5.00	1.00	0.50
Room	5.00	2.00	1.00
	9.00	3.20	1.83

Calculating the priority quality value, for the results of cell division that have been obtained in each row of the matrix are added up, then divided by the number of cells in that row (many criteria = 3).

Table 3 Criterion Eigen Values

	Eigen Value			Total	Priority
	Mobility	Service	Room		
Mobility	0.09	0.06	0.12	0.27	0.09
Service	0.45	0.31	0.29	1.06	0.35
Room	0.45	0.63	0.59	1.67	0.56

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 12, December-2021

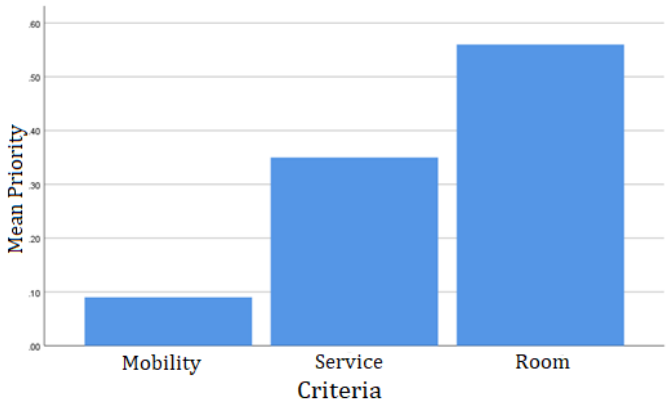


Figure 6 Ranking of Priority Scale Criteria

The priority scale for the need for Tulehu Class II Passenger Terminal Port Facilities is shown in Figure 6, where the order of priority is Rungan with a weight value of 0.56, the second priority is Services with a weight of 0.35 and the third priority is mobility needs of 0.09.

Furthermore, to validate the calculation of the Priority Scale (Eigen Value), the Consistency Index (CI) and lamda values are calculated in the CI formula as follows.

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (1)$$

Where :
The lambda value (λmax) is the average value of the Consistency Vector,
(λmax) = total consistency vector value/ number of project case studies(n)
= 3.07

Then CI = (3.07 -3) / (3-1) = 0.04

Calculation of the CR (Consistency Ratio) value is obtained from the results of the following formula

$$CR = \frac{CI}{RI} \quad (2)$$

Where:
CI is Consistency Index
RI is the mean random consistency index, which is a direct function of the number of alternative risk factors being considered from each case study project. shown in table 4

Table 4 Average Consistency Index Random

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14
R.I.	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54	1.56	1.58

If, $CR = \begin{cases} \leq 0.1 ; pass \\ > 0.1 ; fail \end{cases}$

CR = 0,04/0,52 = 0,07; Pass

Calculations using the Decision Analyst, obtained a comparison of the level of importance of the decision support factors as the AHP model Figure 6. The 3 main factors obtained. The value of Inconsistency Ratio obtained is 0.07 < 0.10 so that the model is considered quite consistent (acceptable) as a decision hierarchy model.

The next stage is to look for sub-criteria values to get more specific priorities, as shown in table 5-7 In each criterion there are sub-criteria to obtain a better decision. The sub-criteria in each Criterion are also analyzed and weighted, as follows:

Table 5 Mobility Sub-criteria Value

Sub-Criteria			Eigen Value		Total	Priority
	A1	A2	A1	A2		
A1	1	1	0,50	0,50	1,00	0,50
A2	1	1	0,50	0,50	1,00	0,50
	2	2				1,00

Table 6 Service Sub-Criteria Value

Sub-Criteria			Eigen Value		Total	Priority
	B1	B2	B1	B2		
B1	1	7	0,88	0,88	1,75	0,88
B2	0,143	1	0,13	0,13	0,25	0,13
	1,143	8				1,00

Table 7 Room Sub-Criteria Value

Sub-Criteria			Eigen Value		Total	Priority
	C1	C2	C1	C2		
C1	1	0,333	0,25	0,25	0,50	0,25
C2	3	1,000	0,75	0,75	1,50	0,75
	4	1,333				1,00

Analysis of the results of the questionnaire calculations by adding Sub-Criteria shows quite detailed results. Furthermore, the results of the Sub-Criteria questionnaire are combined with the calculation of the results of the Criteria calculations as shown in Figure 7 and Table 8

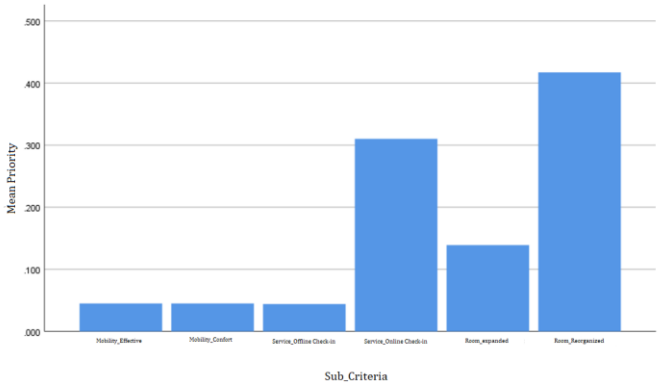


Figure 7 Ranking of Priority Scale Criteria

Tabel 8 Ranking of Criteria and Sub-Criteria

Criteria	Priority	Sub-Criteria	Sub-Priority	Total Priority	Rank
MOBILITY	0,090	Comfort	0,500	0,045	4
		Effective	0,500	0,045	5
SERVICE	0,354	Cek-in Online	0,875	0,310	2
		Cek-in Manual	0,125	0,044	6
ROOM	0,556	Expanded	0,250	0,139	3
		Recognized	0,750	0,417	1

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 12, December-2021

Priority Scale Criteria to improve Tulehu II Port Quality and Services:

1. Reorganized the room to make it more effective (
2. Check-in service can be done online
3. Need to expand the room
4. Passenger mobility must be guaranteed to be effective and comfortable
5. Manual check-in service also needs to be provided
6. Check in manually

B. Alternative

Furthermore, the steps/alternatives that need to be taken to meet the needs of the Tulehu Class II Passenger Terminal Port Facilities are 6 activities that need to be carried out (the questionnaire results details are in Appendix 3), as shown in Figure 8, including:

1. Providing Free Internet Access
2. Adding Counters
3. Doing Effective Spatial Planning
4. Additional Passenger Seats
5. Provide a comfortable/cool room by installing a fan/AC
6. Expanded room

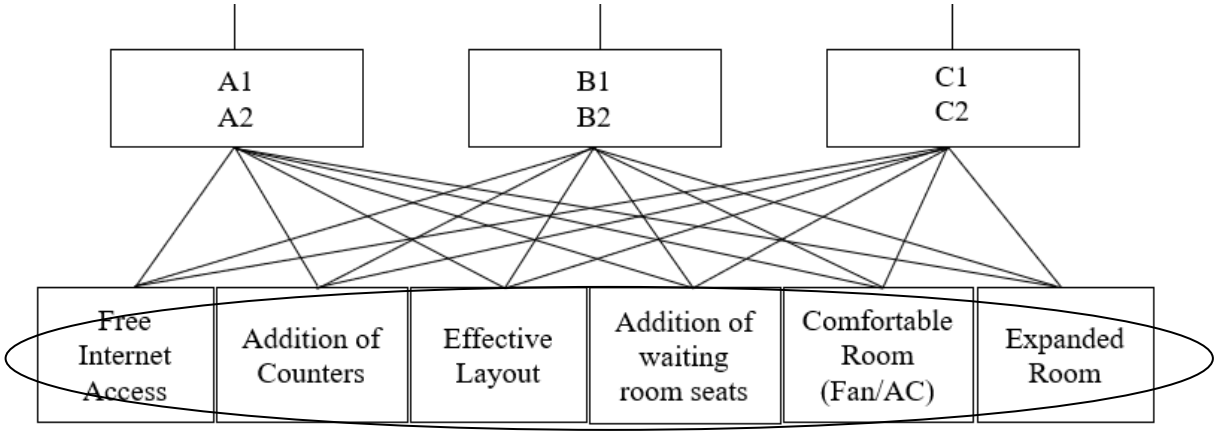


Figure 8 Alternative

Table 9 Alternative Priority

	Mobility		Service		Room		Priorty
	Comfort	Efective	Cek-in online	Cek-in Manual	Expanded	Reorganized	
Free Internet Access	0,015	0,018	0,121	0,002	0,006	0,018	0,180
Addition of Counters	0,019	0,014	0,013	0,005	0,007	0,021	0,079
Effective Layout	0,003	0,006	0,090	0,017	0,014	0,080	0,210
Addition of waiting room seats	0,003	0,002	0,040	0,009	0,016	0,052	0,123
Comfortable room with fan or AC	0,002	0,002	0,027	0,007	0,049	0,114	0,201
Expanded room	0,003	0,003	0,018	0,004	0,047	0,131	0,207

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 12, December-2021

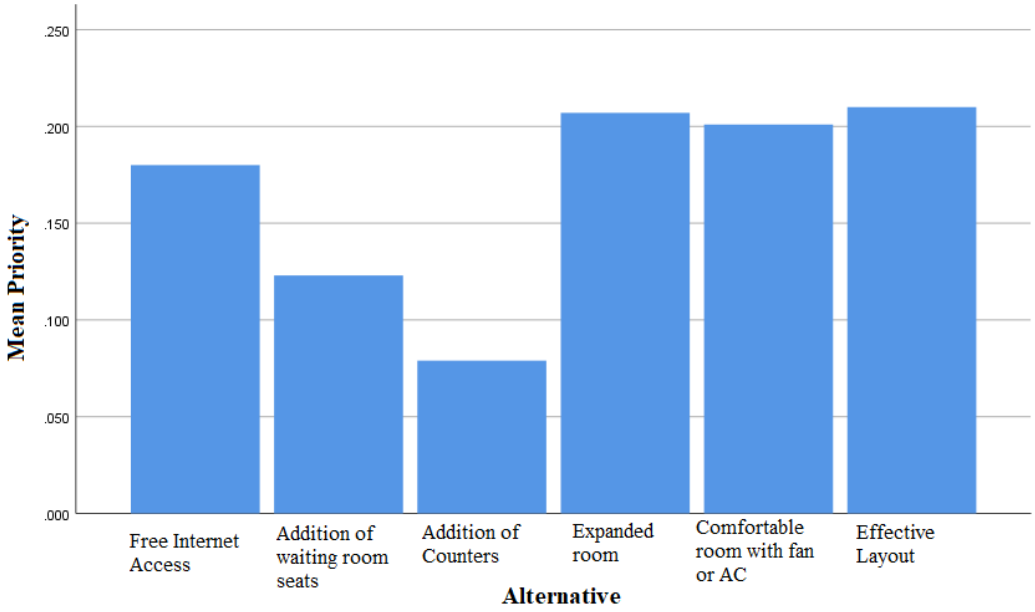


Figure 9 Alternative Priority

AHP as a decision-making method provides the necessary alternatives (actions) as shown in Figure 9, namely;

1. The priority scale that must be done is to rearrange the room
2. The Passenger Waiting Room needs to be expanded
3. Waiting room facilities must be equipped with fans/air conditioners
4. Providing Free Internet Access Facilities in the Port Area for Users
5. The number of seats needs to be added to anticipate additional passengers
6. Additional counters need to be made if needed

V. CONCLUSION

This study provides good input using AHP and provides good flexibility to propose analyzing various alternative options and guidelines on how to deal with real situations. This innovative measurement methodology will provide a more suitable analysis to determine which is a more important measurement factor (priority) which must be carried out by rearranging the room with a weight score of 0.210. This alternative has almost the same value as the expansion of the room and the provision of a cool room with a score of 0.207 and 0.201.

In its implementation, of course, it must consider the availability of funds so that each alternative can be implemented by providing a good response for port service users and providing the maximum revenue contribution to port managers.

ACKNOWLEDGMENT

The author would like to thank Universitas Pattimura for supporting this research

REFERENCES

[1] Bappeda Maluku, 2005, Maluku Province Island Cluster Concept. Regional Spatial Report. Ambon

[2] Basoman Nur, D.M., Knowing the People's Potential in the Sea Transportation Sector" in Dunia Maritim, XIX, No.6, August1969, pg. 14-15.

[3] Center for Statistics and Information of the Ministry of Maritime Affairs and Fisheries, Marine Affairs and Fisheries in Number 2014;

[4] Dick. H.W dan à Campo, "Perahu Shipping in Eastern Indonesia in the Interwar Period" in BIES, Vol. 23, No. 1, April 1987, pg. 104 – 121;

[5] https://republika.co.id/berita/nasional/daerah/16/12/24/oioa05284-penumpang-di-pelabuhan-tulehu-ambon-membludak

[6] UPP TK II Pelabuhan Tulehu. 2020. Data Recapitulation of Ship Visits and Loading and Unloading of Tulehu Seaport 2015-2019. Ambon

[7] DPP Perla, 2000. Association of People's Shipping Regulations. Jakarta

[8] Kramadibrata, S. 2002. Port Planning. Institut Teknologi Bandung, Bandung.

[9] Saaty, Thomas L', (1990). "Decision Making for Leaders - The Analyical Hierarchy process Decisions in a Company World",. RWS publication. pittsburgh, p.7.

[10] Mulyono, S. (2004). Operations Research. Second Edition. Jakarta: Publishing Institute of the Faculty of Economics Universitas Indonesia

[11] Nugraha, E. Y., & Suletra, I. W. (2017). Analysis of the Best Demand Forecasting Method for Oxycan Products at PT. Samator Gresik. National Seminars and Conferences IDEC, 2579–6429.