EEET ECOLOGICAL ENGINEERING & ENVIRONMENTAL TECHNOLOGY

Ecological Engineering & Environmental Technology 2023, 24(7), 38–45
https://doi.org/10.12912/27197050/169460
ISSN 2719-7050, License CC-BY 4.0

Received: 2023.06.09
Accepted: 2023.07.10
Published: 2023.08.15

Analysis of Inhibiting Factors in Shipyards in Clusterizing Shipyards on the Northern Coast of Aceh Indonesia Using the Fuzzy AHP Method – A Preliminary Study

Thaib Rizwan[1*], Makwiyah A. Chaliluddin[1], Hayatun Nuvus[1], Muhammad Arif[2], Yusrizal Muchlis[3], Akhyar Akhyar[4]

[1] Department of Capture Fisheries, Faculty of Marine and Fisheries, Universitas Syiah Kuala (USK), Jl. Syech Abdurrauf No. 7, Darussalam, Banda Aceh, 23111, Indonesia

[2] Department of Fisheries, Faculty of Fisheries and Marine Sciences, Teuku Umar University, Meulaboh, West Aceh, Indonesia

[3] Department of Mechanical Engineering, Faculty of Engineering, Abulyatama University, Aceh Besar, Indonesia

[4] Department of Mechanical Engineering, Faculty of Engineering, Universitas Syiah Kuala (USK), Jl. Syeh Abdurrauf No. 7, Darussalam, Banda Aceh, 23111, Indonesia

* Corresponding author's email: rizwanthaib@usk.ac.id

ABSTRACT

The fishing shipyard in Banda Aceh City is a privately owned shipyard and is managed in a family manner. The shipyard here is active in carrying out maintenance, repair and construction of new ships when there is demand from consumers. The shipyards in Banda Aceh City generally make ships made of wood. The problem that is currently being faced is that there are many abandoned ships due to lack of finance, natural resources, human resources and environment, this is an obstacle to the progress and development of shipyards. The purpose of this study was to determine the inhibiting factors that exist in shipyards in the city of Banda Aceh and find alternative solutions to these problems. The method used in this study was a survey method used to look at existing symptoms and collect data on the factors related to research variables and then analyzed using the Fuzzy AHP method. The results of this study indicate that the financial inhibiting factor is the most influential factor in shipyards with a resulting value of 0.4635, the inhibiting factor of Natural Resources is worth 0.35675, the inhibiting factor of Human Resources is worth 0.2865 and the inhibiting factor from the environment is the inhibiting factor which is the lowest or less influential with a value of 0.14325. The alternative solutions to financial problems are capital loans and investments. An alternative for natural resources is the addition of a minimum stock to anticipate stock scarcity and delays in the delivery of materials and tools. The alternative for human resources is the existence of an office, organizational structure, and division of tasks as well as raising awareness of occupational health and safety. As for the alternatives for the environment, namely the need for buildings or installation of tarpaulins for the areas where ships are built, good land management and studies of other natural impacts.

Keywords: fuzzy AHP, shipyard, inhibiting factor.

INTRODUCTION

Indonesia is included in a maritime country where most of its area is surrounded by oceans, the huge and abundant potential of the sea must be utilized to support the economy and improve the welfare of its people. One way to maximize the potential benefits of the sea is by optimally empowering fishing vessels [1]. Fishing vessels are a means of determining the success of fishing operations apart from fishermen and fishing gear [2]. According to Cebi [3], the good condition of the ship is one of the factors that determine the safety of the crew. Therefore, it is necessary

to have a shipyard to repair, build and maintain ships. Shipbuilding is an industry supporting capture that can meet the needs of ship repair [4].

According to Putra et al, [5] the lack of a lines strategy and the reliance only on experience are two issues with the traditional shipbuilding sector. Basic tools are still in use. These problems limit the shipyard's capacity to create. Kambase [6] according to his research, reported that some of the major issues affecting ship maintenance and repair services in shipyards at the moment include a shortage of capacity, out-of-date maintenance equipment, a lack of equipment, and a lack of skilled labor.

The construction of fishing vessels in Banda Aceh is generally still traditional, that is, it is not based on calculations of shipping architecture (Naval Architecture) and not all of them follow the rules of the Indonesian Classification Bureau (BKI) like modern shipbuilding [7]. The term "traditional" refers more to the method or the method used by fishing boat builders in constructing their boats, where the way of working or the method used is a legacy from their predecessors. Shipbuilding in the City of Banda Aceh uses wood as a raw material because wood is more economical than Fiber Glass ships which according to shipbuilders are expensive to maintain and more difficult to manufacture than ordinary wooden ships [8].

The fishing shipyard business in the city of Banda Aceh continues well when consumers have a need, and manufacturers are able to fill that need. The availability of raw materials, raw material prices, demand, the presence of outside competitors who are the competitiveness of the shipyard business, and regulations governing the shipyard business are some of the factors that have an impact on the sustainability of the shipyard industry. This research will also look at some of these factors. To determine the sustainability of this shipyard business, a review can be carried out regarding the components that are the forming aspects of the shipyard business [9].

On the basis of the research conducted, the problem in the Banda Aceh City shipyards is the large number of abandoned ships due to the difficulty in obtaining the necessary raw materials and the lack of proper management of the shipyards. Therefore, the purpose of this research was to find out the inhibiting factors in shipyards in Banda Aceh City and find alternative solutions to these problems.

RESEARCH METHOD

Time and place

This research was carried out at traditional shipyards at three locations in Banda Aceh City, namely Gampong Jawa, Lampulo, and Gampong Mulia.

Method of collecting data

The method of collecting data in this study was carried out by means of observation and interviews (interviews). The data collected in this study are in the form of primary and secondary data.

Primary data collection is carried out using a questionnaire with a closed method so that the questions have been determined in advance and direct interviews with producers or shipyard workers as many as 10 people to find out the inhibiting factors and constraints as well as the efforts that have been made by producers or shipyard workers to control losses due to constraint.

Secondary data is data collection by studying report books, previous studies, and existing journals.

Data analysis

The data analysis method used in this research involves fuzzy AHP. Fuzzy Analytic Hierarchy Process (F-AHP) is one of the ranking methods. F-AHP is a combination of the AHP method with the Fuzzy concept approach. F-AHP can cover the weaknesses found in the AHP method, namely in problems with criteria that have a more subjective nature. The uncertainty of numbers is represented by the order of the scale. To determine the degree of membership in the F-AHP, function rules are used in the form of Triangular Fuzzy Numbers (TFN) which are arranged based on linguistic sets [10].

The advantage of this model is that the upper and lower limits are obtained so that the lowest and highest values of a problem result can be identified. The steps of the FAHP method are as follows:

Arrange the problem in a hierarchical form, the following is the hierarchical form of this research (Fig. 2).

Matrix of expert opinion. Making a matrix of expert opinions is done by forming a pairwise comparison matrix to describe the effect of each element. Making the matrix is done by giving a questionnaire [11].

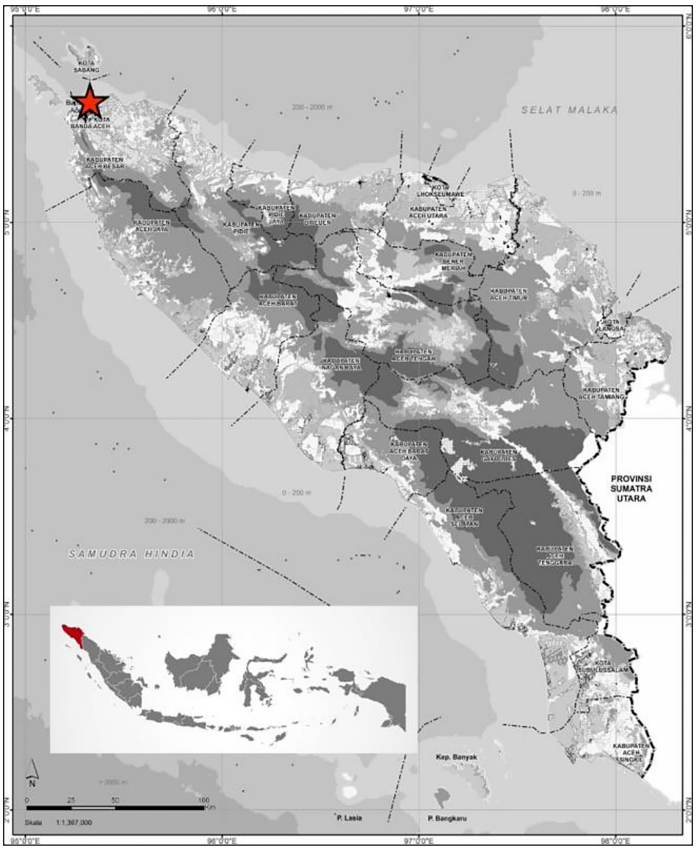

Figure 1. Map of research locations

Table 1. Fuzzy value scale

Intensity	Linguistic Variable	Triangle fuzzy number (TFN)	Resiprocal TFN
1	Comparison of two similar elements	(1,1,1)	(1,1,1)
2	The two elements have the same importance	(1/2, 1, 3/2)	(2/3, 1, 2)
3	One element is slightly more important than the other	(1, 3/2, 2)	(1/2, 2/3, 1)
4	The two elements have the same importance	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
5	One element is more important than the other	(2, 5/2, 3)	(1/3, 2/5, 1/2)
6	The two elements have the same importance	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)
7	One element is significantly more important than the other	(3, 7/2, 4)	(1/4, 2/7, 1/3)
8	The two elements have the same importance	(7/2, 4, 9/2)	(2/9, 1/4, 2/7)
9	One element is absolutely more important than the other	(4, 9/2, 9/2)	(2/9, 2/9, 1/4)

Note: source – Turkan et al., 2019.

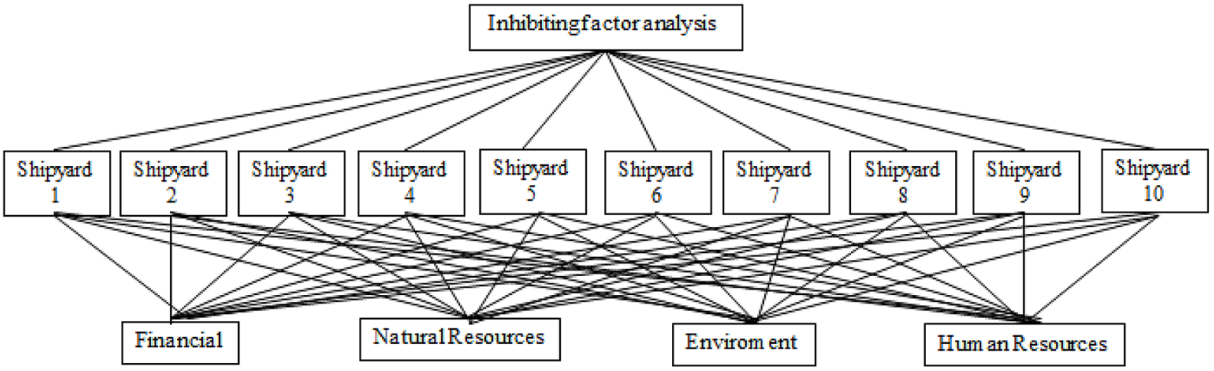

Figure 2. Issue hierarchy

Compile a comparison matrix between all elements or criteria using the Triangular Fuzzy Number (TFN) scale which can be seen in the table above. The Fuzzy value scales.

Determine the value of Fuzzy Synthetic Extent (Si). According to Suciadi [12], determining the Fuzzy Synthetic Extent (Si) value of each criterion in the main criteria matrix is as follows:

$$Si = \sum_{j=1}^{m} M_{g^i}^{i} \oplus \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g^i}^{i}\right]^{-1} \quad (1)$$

From the formula above, the inverse calculation of the sum of the TFN results for each main matrix is obtained as follows:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g^i}^{i}\right]^{-1} = \left(\frac{1}{\sum_{j=1}^{m} l_j}, \frac{1}{\sum_{j=1}^{m} m_j}, \frac{1}{\sum_{j=1}^{m} u_j}\right) \quad (2)$$

where: Si – fuzzy synthetic extent;
M – triangular fuzzy number (TFN);
i – row index;
j – column index;
$\sum_{j=1}^{m} M_{g^i}^{i}$ – total value of each column starting from column 1 in each column;
$\sum_{j=1}^{m} l_j$ – total value of 1 first column (bottom);
$\sum_{j=1}^{m} m_j$ – The total value of the first (medium) m columns;
$\sum_{j=1}^{m} u_j$ – total value of u first (top) column.

Calculate the priority value of the vector. The eigenvectors or priority vectors are the element weights. Calculating the priority value of the vector uses the following formula:

$$V\ (M_2 \geq M_1) = \begin{cases} 1 & ,if\ m_2 \geq m_2 \\ 0 & if\ l_1 \geq u_2 \\ \dfrac{(l_1 - u_2)}{(m_2 - u_2) - (m_1 - l_1)} & ,otherwise \end{cases} \quad (3)$$

where: M_1 – triangular fuzzy number of each criterion (K_i);
V – vector or comparison;
m – median value (middle possibility);
l – lower value (lowest possibility);
u – upper value (top possibility).

To compare the values of M_1 and M_2, it takes the values $V(M_2 \geq M_1)$ and $V(M_1 \geq M_2)$ the benchmark of which is m_1. If the M_1 value is greater than the M_2 value, the value is 1. If the M_1 value is less than the M_2 value, the formula is used:

$$V\ (M_2 \geq M_1) = \frac{l_1 - u_2}{\left((m_2 - u_2) - (m_1 - l_1)\right)} \quad (4)$$

Determine the normalized weight value (vector weight value). Normalization of fuzzy vector weight values (W). After normalizing the equation in step (2-5), the normalized vector weight values are as follows:

$$V\ (M_2 \geq M_1) = \frac{l_1 - u_2}{\left((m_2 - u_2) - (m_1 - l_1)\right)} \quad (5)$$

where: W – a non-fuzzy number.

Ranking the results of fuzzy calculations. After all calculations have been completed, ranking is carried out on which criterion is the most influential and which alternative is most needed.

Application

In this section, the Fuzzy technique was used to analyze the inhibiting factors in the shipyard in Banda Aceh City, the following is Table 2 which shows the parameters observed for the determination of inhibiting factors in shipyards and Table 3 shows the list of criteria.

Based on the observation parameters, it is possible to determine the shipyard inhibiting parameters which are also called alternatives as shown in Table 4.

Weight assessment on alternatives using a scale as shown in the Table 5. Conduct an assessment of the shipyard based on predetermined inhibiting factors. the assessment is based on the weight value as shown in Table 5. The results of

Table 2. Observation parameters

Number	Observation parameters
1	Lack of capital in the manufacture or repair of ships
2	It is difficult to get the necessary raw materials
3	Delay in delivery of raw materials
4	There are no office buildings and storage warehouses
5	Lack of awareness of OSH
6	Rain intensity
7	Erosion and sedimentation rates

Table 3. List of criteria

Code	Criteria Name	Research sites
C1	Shipyard 1	Gampong Jawa
C2	Shipyard 2	Gambong Jawa
C3	Shipyard 3	Gampong Jawa
C4	Shipyard 4	Gampong Jawa
C5	Shipyard 5	Gampong Jawa
C6	Shipyard 6	Gampong Mulia
C7	Shipyard 7	Gampong Mulia
C8	Shipyard 8	Lampulo
C9	Shipyard 9	Lampulo
C10	Shipyard 10	Lampulo

Table 4. Alternatives

Code	Inhibiting factors
A1	Financial
A2	Natural resources
A3	Enviroment
A4	Human resources

the descriptive assessment can be seen in Table 6 while the results of the numerical assessment are presented in Table 7.

Based on Tables 6 and 7, Fuzzy calculations can be carried out as in Table 8.

RESULTS AND DISCUSSION

On the basis of theresearch that has been conducted on 10 shipyards spread across three different locations, namely GampongJawa, GampongMulia

Table 5. Weight of alternative criteria values

Weight value	Description of the weight value
1	Very good
0.75	Good
0.5	Fair
0.25	Less
0	Very less

Table 6. Criteria weight input for each alternative

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	Less	Good	Fair	Fair	Less	Very less	Less	Very less	Fair	Less
A2	Less	Fair	Fair	Fair	Less	Fair	Less	Less	Fair	Less
A3	Less	Very less	Less	Less	Less	Less	Less	Fair	Less	Good
A4	Fair	Very less	Less	Fair	Fair	Good	Less	Good	Good	Fair

Table 7. Conversion of criteria weight values from each alternative

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	0.25	0.75	0.5	0.5	0.25	0.00	0.25	0.00	0.5	0.25
A2	0.25	0.5	0.5	0.5	0.25	0.5	0.25	0.25	0.5	0.25
A3	0.25	0.00	0.25	0.25	0.25	0.25	0.25	0.5	0.25	0.75
A4	0.5	0.00	0.25	0.5	0.5	0.75	0.25	0.75	0.75	0.5

Table 8. Fuzzy calculations

	Fuzzy triangular number			Fuzzy synthesis			Vector weights	Normalization	
	l	m	u	l	m	u	Value	Min	Value
C1	17	21	24.5	0.11	0.17	0.25	1,1,1,1,1,1,1,1,1,1	1	0.57
C2	13	16.67	20.5	0.08	0.13	0.21	0,745,1,1,1,1,1,1,1,1,1	0.74	0.43
C3	8.83	12.57	16.5	0.05	0.10	0.17	0,0.723,0.944,1,0.761,1,1,1,1	0	0
C4	10.58	13.35	16.33	0.07	0.10	0.17	0,0,1,1,0.8,1,1,1,1	0	0
C5	8.80	11.07	13.58	0.06	0.09	0.14	0,0,0,0.798,0.589,1,1,1,1	0	0
C6	13.07	15.9	20.17	0.08	0.13	0.20	0,0,0,0,1,1,1,1,1	0	0
C7	0.07	9.9	13.17	0.05	0.08	0.13	0,0,0,0,0,0.515,1,1,1	0	0
C8	6.24	7.15	8.36	0.04	0.05	0.07	0,0,0,0,0,0,0.614,0.821,1	0	0
C9	6.23	8.40	13.17	0.04	0.07	0.13	0,0,0,0,0,0,0,1,1	0	0
C10	5.81	7.19	10.5	0.037	0.06	0.108	0,0,0,0,0,0,0,0,0.872	0	0
Total	97.65	123.2	156.77						

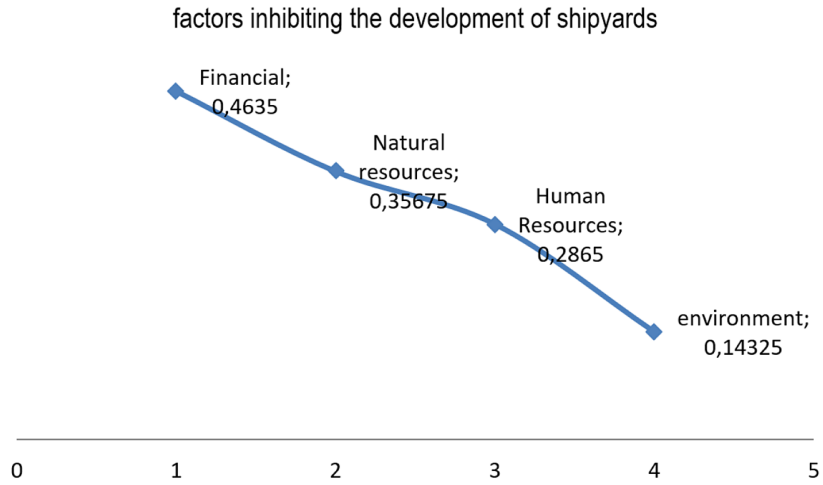

Figure 3. Graph of research results

and Lampulo, it is known that several inhibiting factors are found in several shipyards including: Financial, Natural Resources, Human Resources and Environment. The inhibiting factors on these shipyards were analyzed using the Fuzzy AHP method. The ranking results for each of these inhibiting factors can be seen in the graph (Fig. 3).

On the basis of the graph above, it is known that the highest ranking in this study is the financial factor which is the most inhibiting factor in the shipyard in Banda Aceh city with a value of 0.4635 and the lowest factor is the environment with a value of 0.14325. Then, the inhibiting factors will be sought alternative solutions. The following alternative solutions are offered for these inhibiting factors:

Financial

On the basis of the financial problems discussed earlier, a suitable alternative is to borrow capital and invest from outsiders. This is in accordance with the statement [13]. Capital is a source of fear when the industry has started to be pioneered but it is difficult to grow and develop. Capital issues include how to determine business capital needs, and how to obtain funds or sources of capital and procedures for managing limited capital to achieve maximum benefits. In connection with the problem of limited capital an industry requires support from financial institutions including banks, cooperatives, and others [14].

Natural resources

On the basis of the problem of material scarcity such as raw materials and material delivery delays, the appropriate alternative is to consider adding a minimum stock to the warehouse to anticipate raw material shortages. The next alternative solution is to have a backup or use a backup supplier if the main supplier experiences problems in the procurement process or not. can fulfill orders. Reserve suppliers should prioritize local suppliers to facilitate the process of sending materials [15].

Human resources

On the basis of the problem, there are no offices and warehouses for storing tools and materials in the Banda Aceh City shipyard, which causes the management of the shipyard to be less organized. According to Rizwan [16], a shipyard must provide an office building; this serves to make it easier when outsiders come to the shipyard to place orders for ships. According to Ekoanindiyo [17] warehouses in industry have an important role because they function as a place to store materials and tools from exposure to sunlight and rain which result in a decrease in the quality of raw materials.

Besides, related to the problem of lack of awareness of Occupational Health and Safety (OSH), the alternative needed is to create a safe and comfortable work atmosphere. The proprietor or supervisor of the dockyard must endeavor to enforce safety measures effectively. To attain the goal of ensuring the safety of dockyard laborers, it is imperative to create an Occupational Health and Safety (OSH) scheme. The initial action to be taken is to compile a roster of prerequisites in the dockyard to satisfy OSH prerequisites. As a reference, one can refer to

the standards outlined in the Government Regulation of the Republic of Indonesia Number 50 of 2012 about the OSH Management System. Implementing OSH is an attempt to avert mishaps, work-related ailments, and machinery impairment [18].

Environment

In terms of the problems in the shipyard environment such as high rain intensity, an alternative solution can be done by installing tarpaulin in the area where shipbuilding work will be carried out when there are signs that it will rain so that work that is not related to electricity can still be carried out and can protect materials and equipment work from the occurrence of rain [19].

As for erosion and sedimentation problems, exploring the issue of erosion and sedimentation processes can lead to diverse options to address the challenges posed by the excessive sedimentation rate in a watershed. It is crucial to identify effective remedies for issues linked to high sedimentation levels [20]. In general, the management of sedimentation can be categorized into four distinct activities, which include decreasing the rate of erosion in the upstream region, decreasing the quantity of sediment that is deposited in the reservoir, decreasing the sediment load that enters the reservoir, and eliminating sediment buildup in shipping channels. Additionally, other actions that can be taken include land management and community involvement in sedimentation management [20].

CONCLUSIONS

The conclusion of this study is that after processing the data using Fuzzy AHP it is known that the results obtained for financial inhibiting factors are 0.4635, natural resources are 0.35675, human resources are 0.2865 and environment are 0.14325.

Acknowledgments

Authors greatly thank LP3M USK for funding in this research in the 2023 fiscal year under number 146/UN11.2.1/PT.01.03/PNPB/2023, Ayana Rizki, S. Pi, (Shipyard and Navigation Lab, PSP USK) for collecting data. Marine and fisheries service officer of Aceh Province.

REFERENCES

1. Farhum S.A., Paradhita L., Ihsan Y. N. 2020. Utilization of Vessel Multi Aid (VMA) as a smart fishing technology for small scale fisheries.Iop Conf. Ser. Earth Environ. Sci., 564(1), 012081.
2. Demirel H., Balin A., Celik E., Alarçin F. 2018. A fuzzy AHP and electre method for selecting stabilizing device in ship industry. Brodogradnja, 69, 61–77.
3. Cebi S., Akyüz E., Sahin Y. 2017. Developing web based decision support system for evaluation occupational risks at shipyards, Brodogradnja, 68(1), 17–30.
4. Rizwan T., Husaini H., Husin H., Akhyar A., Jalil Z. 2023. Identification shipyard model suitable for kutaraja fishing port in Aceh, Indonesia. Pol. J. Environ. Stud., 32(2), 1755–1766.
5. Putra R.D., KotoJ. 2015. Production process of traditional ship inBintan-Indonesia. Journal of Ocean, Mechanical and Aerosace, 21, 7–11.
6. Kambase N.N. 2020. Ship maintenance and repair services in the tema drydock and shipbuilding yard in Ghana: some challenges, opportunities and prospects. World J. Eng. Technol., 8(3), 296–316.
7. Rizwan R., Setiawan I., Rahimi S.A.E., Dewiyanti I., Purnama N.R., Arif M. 2017. Desain dan studi konstruksi kapal purse seine bermaterial kayu di Pelabuhan Perikanan Samudera (PPS) Lampulo. Pros. Semin. Nas. USM, 1(1), 91–99.
8. Syahputra F., Nataya A.H., Mukhlis M., Naufal A., Hayati N., Thaib A., Nazlia S., Handayani L. 2022. Identifikasi kebutuhan bahan material untuk pembuatan kapal kayu tradisional diKampung Jawa, Kota Banda Aceh. Mahseer J. Ilmu-Ilmu Perair. Dan Perikan., 4(2), 15–21.
9. Rizwan T., Ayana R., Muchlis Y., Aprilla R.M., Chaliluddin M.A., Muhammad M., Affan J.M., Amir F. 2020. Studi Klasterisasi industri galangan kapal kayu berdasarkan ukuran kapal perikanan di Banda Aceh dan Aceh Besar dengan menggunakan Metode Analytical Hierarchy Process (AHP).Depik, 9(2), 356–354.
10. Tukan M., Camerling B., Afifudin M.T., Hozairi H. 2019. Analisa kelayakan wilayah untuk pembangunan floating dock sebagai dok alternatif di Kepulauan Maluku menggunakan Fahp-Topsis.Njca Nusant. J. Comput. Its Appl., 4, 116.
11. Septifani R., Santoso I., Pahlevi Z. 2018. Analisisrisikoproduksifrestea menggunakan Fuzzy Failure Mode and Effect Analysis (Fuzzy FMEA) dan Fuzzy Analytical Hierarchy Process (Fuzzy AHP) (Studi Kasus Di PT. Coca-Cola Bottling Indonesia Bandung Plant).Proc. Natl. Colloq. Res. Community Serv., 2, 13–21
12. Suciadi Y. 2013. Pemilihan dan evaluasi pemasok pada P.T. New Hope Jawa Timur dengan

menggunakan metode Fuzzy Analytic Hierarchy Process.Calyptra, 2(1), 1–17.

13. Reschiwati, Effrida, Ibrahim I.M. 2021. The role of financial performance of indonesia's banking firms in influencing the rate of stock return. International Journal of Latest Engineering and Management Research (IJLEMR), 6(3), 20–32.
14. Sihaloho T., Muna N. 2010. Kajian dampak ekonomi pembentukan kawasan ekonomi khusus.Bul. Ilm. Litbang Perdagang., 4(1), 75–101.
15. Mishra P., Mishra P., Purohit R. 2018. Material Delivery Problems In Construction Projects: A Possible Solution.mater. today proc., 5(2), 6497–6501.
16. Rizwan T., Hikmah D., Muhammad M., Chaliluddin M.A., Akhyar A.,Thaib R. 2022. A study on the development of a fishing shipyard in peukan bada district, Aceh Besar using fishbone analysis: a short comunnication. Depik, 11(2), 246–251.
17. F.A. Ekoanindiyo and Y.A. Wedana.2012. Perencanaan tata letak gudang penggunakan metode shared storage di pabrik plastik Kota Semarang. Din. Tek. Ind., 6(1),46–56.
18. Y.R.M.B. Sitompul and V.P.A. Simarmata. 2022. Description of work accident and occupational safety and health activities of paint manufacturing industry PTSU, In West Java 2016–2017.*Int. J. Health Sci. Res.*, 12 (8), 280–289.
19. A.A.A. Dharma. 2013. Perencanaan jaringan kerja pada erection block kapal untuk meningkatkan efisiensi waktu pembuatan (studi kasus di PT. Dok dan Perkapalan Surabaya),*J. Tek. Mesin*, 1(2), 42–51.
20. T. Rizwan, Z. Jalil, A. Akhyar, and H. Husaini. 2021. Oceanographic Factors as the indicators for shipyard industry development in Kutaraja Fishing Port: a preliminary study. J. Ecol. Eng., 22(9), 237–245.