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Seaworthiness analysis of pole and liner in Luwu Regency

Resky Dwiyanti Risa, St. Aisjah Farhum, Alfa Nelwan and Ahmad Faizal

Faculty of Marine Science and Fisheries, Hasanuddin University

Email : aisyahfarhum@gmail.com

Abstract. Pole and liner have a large shipping area with unstable marine environmental conditions, therefore, the operation of pole and liner should pay attention to vessel's seaworthiness criteria. The vessel's seaworthiness criteria can be seen from the index of fishing vessel standards which in principle is based on aspects safety, which includes safety equipment, navigation equipment, communication equipment, machinery and other additional equipment. This study aims to analyze the marine feasibility of pole and liner in Luwu Regency, by using a decision-making method based on the Analytic Hierarchy Process (AHP) by comparing the elements of decisions based on pairs, namely comparing pairs and reducing the concept of decision making. The data used in analyzing the seakeeping of the vessel for the seaworthiness aspect is obtained from the results of interviews with respondents using a questionnaire which includes parameters of safety equipment, navigation equipment, and additional equipment. The results of the pole and liner seaworthiness assessment in Luwu Regency based on three parameters show that for the aspect of safety equipment, the ones with the highest weight are life jackets, life buoy, lifeboats, and fire extinguishers, respectively. Marine maps and Global Position Systems (GPS) achieve the highest weight for the navigation equipment aspect and for the auxiliary equipment aspect with the highest weight, i.e. engine parts.

1. Introduction

In general, the dynamics of vessels at sea can be seen from the seakeeping. seaworthiness is one part of the main criteria that must be met by a seakeeping. Seaworthiness is an indication of safety in extreme conditions, the ship's ability to survive in all dangers at sea such as collisions, aground, and other effects related to bad weather [1].

The operation of vessels at sea should pay attention to the criteria of the vessel's seaworthiness, because fishing vessels, especially pole and liner have a large shipping area with unstable marine environmental conditions. The marine eligibility criteria can be seen from the index of the fishing vessel marine standards which in principle is based on safety aspects, which includes safety equipment, navigation equipment, communication equipment, engines and other additional equipment. Based on the Directorate of Fishing Vessels (2011) [2]. regarding fishing vessel safety equipment that should be equipped as in Table 1.

Table 1. List of Fishing Vessel Safety Equipment [2]

List of Safety Equipment	Basic	1	2	3
Life buoy	√			
Life jacket	√			
Flashlight	√			
Rope connected to the vessel	√			
Paddle		√		
Compass		√		
Marine maps		√		
FM radio		√		
Fire extinguisher				
Global Positioning System (GPS)			√	
VHF Radio				√
Mobile phone				√
For motorized vessels (optional)				
Sail and a mast				
Spare part of the engine	√			
Extra fuel of the engine	√			

2. Method

2.1. Collecting Data

The data used in analyzing seaworthiness were obtained from interviews with respondents (Table 2) using a questionnaire which would then be analyzed using *Analytic Hierarchy Process* (AHP).

Table 2. Criteria for Respondents

Agency	Criteria
Academics	Fishing Field
Indonesian Classification Bureau	Ship Technical Field
Fisherman	Working ± 2 years
Syahbandar	Shipworthiness Field

2.2. Data analysis

Evaluation of standard criteria for marine feasibility uses a decision-making method based on a Analytic Hierarchy Process comparing decision elements based on pairs, namely comparing pairs and reducing the concept of decision making.[3] This method was first developed by Saaty (1980) known as the Analytic Hierarchy Process (AHP). The weight of the parameter is determined by normalizing the eigenvector, which is associated with the maximum eigen value in the ratio matrix.

Table 3. Pairwise Comparison Matrix [4]

Value	Definition
1	Just as important
2	The same is quite important
3	Quite important
5	Important enough to high importance
5	High importance
6	High importance to very high
7	Very high importance
8	Its importance is very high to very, very high
9	Its importance is very, very high

2
The calculation of the weight of each parameter is calculated using the pair comparison method, with the assumption that if the CR value is <0.10 then it shows a good level of consistency or sensitivity, meaning that the weight obtained is quite rational, but if CR > 0.10 then there has been an inconsistent assessment of value, sensitivity is not good.

3. Results and Discussion

Seaworthiness in this study consists of three aspect criteria, namely aspects of safety equipment, navigation equipment, and additional equipment on vessels.

3.1. Safety Equipment Aspects

Based on the 2011 Directorate of Fishing Vessels concerning Fishing Vessel Safety Equipment and the Decree of the Minister of Transportation No. KM 46 of 1996 [5] concerning Certification of Marine Affairs and Manning of Fishing Vessels, that the standards for fishing vessel safety equipment are as follows:

- a. Life buoy
- b. Life jacket
- c. Flashlight
- d. Rope connected to the vessel
- e. Life boat
- f. Life raft
- g. Fire extinguisher
- h. FM radio
- i. Radio VHF
- j. Mobile phone

Each safety equipment has its own criteria, so safety equipment can have different values. To explain the effect of each criterion on each of the criteria which can be seen in Table 3, data analysis was carried out using the pair comparison method.

The results of the study using the pair comparison method questionnaire are shown in Table 4. In this table, the highest importance value only reaches a value of 5 (high importance) between life buoy and mobile phone, and life jacket and mobile phone.

Table 4. Important Values Comparison Between each pair Criteria Fishing Vessel Safety Equipment

Parameter 1	Parameter 2	Important value
Life buoy	Life jacket	1
Life buoy	Flashlight	3
Life buoy	Rope connected to the vessel	4
Life buoy	Life boat	3
Life buoy	Life raft	3
Life buoy	Fire extinguisher	1
Life buoy	FM radio	4
Life buoy	Radio VHF	3
Life buoy	Mobile phone	5
Life jacket	Flashlight	3
Life jacket	Rope connected to the vessel	4
Life jacket	Life boat	2
Life jacket	Life raft	3
Life jacket	Fire extinguisher	2
Life jacket	FM radio	4
Life jacket	Radio VHF	4
Life jacket	Mobile phone	5
Flashlight	Rope connected to the vessel	2
Flashlight	Life boat	1
Flashlight	Life raft	1
Flashlight	Fire extinguisher	1
Flashlight	FM radio	2
Flashlight	Radio VHF	1
Flashlight	Mobile phone	2
Rope connected to the vessel	Life boat	1
Rope connected to the vessel	Life raft	1
Rope connected to the vessel	Fire extinguisher	1
Rope connected to the vessel	FM radio	2
Rope connected to the vessel	Radio VHF	1
Rope connected to the vessel	Mobile phone	2
Life boat	Life raft	3
Life boat	Fire extinguisher	2
Life boat	FM radio	3
Life boat	Radio VHF	2
Life boat	Mobile phone	4
Life raft	Fire extinguisher	2
Life raft	FM radio	3
Life raft	Radio VHF	2
Life raft	Mobile phone	3
Fire extinguisher	FM radio	3
Fire extinguisher	Radio VHF	2
Fire extinguisher	Mobile phone	4
FM radio	Radio VHF	1
FM radio	Mobile phone	1
Radio VHF	Mobile phone	2

The table shows that most of the respondents stated that between one criterion and another it has an important value of 2 (equal to quite important). Furthermore, to see the effect of each criterion in the Directorate of Fishing Vessels 2011 [2] concerning Fishing Vessel Safety Equipment and the Decree of the Minister of Transportation No. KM 46 of 1996 concerning Marine Certification and Manning of Fishing Vessels for the aspect of safety equipment, a pair comparison analysis was carried out [3]. Based on this analysis, the weight of each criterion is obtained as in Table 5.

Table 5. Value of each fishing vessel marine standard criteria in the aspect of equipment safety

Criteria	Value
Life buoy	0.19
Life jacket	0.20
Flashlight	0.08
Rope connected to the vessel	0.06
Lifeboat	0.12
Life raft	0.09
Fire extinguisher	0.10
FM radio	0.04
Radio VHF	0.05
Mobile phone	0.03
Consistency Ratio Value (CR) = 0.029	

The value of each criterion in the analysis results in the table is acceptable because the sensitivity test results obtained a value of CR = 0.029 where if the CR value <0.1 indicates a rational consistency ratio, it means that the respondent is very consistent in assessing each criterion. The value of each of these parameters shows that the life jacket (0.20) is a major factor as safety equipment in fishing vessel marine safety standards, the next important safety equipment is life buoy (0.19), lifeboat (0.12), and fire extinguisher (0.10), meanwhile, the safety equipment that has the lowest score is the mobile phone (0.03).

3.2. Aspects of Navigation Equipment

Based on the Directorate of Fishing Vessels (2011), it is explained that the standard index of fishing vessel marine worthiness is principally based on the following aspects of navigation equipment:

- a. Compass
- b. Marine maps
- c. Global Positioning System (GPS)
- d. Echosounder

The results of the research using the pair comparison method questionnaire shown in Table 6 show that the highest importance value which only reaches a value of 2 (equal to quite important) is the marine map and the Global Positioning System (GPS).

Table 6. Importance of Pair Comparison between Each Criteria for Fishing Vessel Navigation Equipment

Parameters 1	Parameters 2	Important value
Compass	Marine maps	1
Compass	GPS	1
Compass	Echosounder	1
Marine maps	GPS	2

Marine maps	Echosounder	1
GPS	Echosounder	1

The table shows that most respondents stated that between one criterion and another have an important value of 1 (equally important). Furthermore, to see the effect of each criterion at the Directorate of Fishing Vessels (2011) [2] on the standard index of fishing vessel marine worthiness for the aspect of navigation equipment, a pair comparison analysis was carried out [3]. Based on this analysis, the weight of each criterion is obtained as in Table 7.

Table 7. The Value of Each Criteria for Fishing Vessel Marine Standards in the Aspect of Navigation Equipment

Criteria	Score
Compass	0.21
Marine map	0.25
Global Positioning System (GPS)	0.25
Echosounder	0.21

Consistency Ratio Value (CR) = 0.055

The value of each criterion in the analysis results in the table is acceptable because the sensitivity test results obtained a value of CR = 0.055 where if the CR value <0.1 indicates a rational consistency ratio, it means that the respondent is very consistent in assessing each criterion. The value of each of these parameters shows that the marine map (0.25) and the Global Position System (GPS) (0.25) are the main factors as a tool in fishing vessel marine standards in the aspect of navigation equipment, followed by a compass (0.21) and an echosounder (0.21).

3.3. Additional Equipment Aspects

Based on the Directorate of Fishing Vessels (2011) [2], it is explained about the standard index of fishing vessel marine worthiness in the aspect of additional equipment as follows:

- a. Sail and a mast
- b. Spare part of the engine
- c. Extra fuel of the engine

The results of the research using the pair comparison method questionnaire are shown in Table 8. It shows that the highest importance value only reaches a value of 2 (equal to quite important), namely between engine parts and fuel.

Table 8. The Importance of Pair Comparison Between Each Criteria for Fishing Vessel Equipment

Parameters 1	Parameters 2	Important value
Sail and a mast	Spare part of the engine	1
Sail and a mast	Extra fuel of the engine	1
Spare part of the engine	Extra fuel of the engine	2

The table also shows that most respondents stated that between one criterion and another has an important value of 1 (equally important). Furthermore, to see the effect of each criterion at the Directorate of Fishing Vessels (2011) [2] on the standard index of fishing vessel marine worthiness for the aspect of navigation equipment, a pair comparison analysis was carried out [3]. Based on this analysis, the weight of each criterion is obtained as in Table 9.

Table 9. The Value of Each Criteria for Fishing Vessel Marine Standards in the Aspect of Additional Equipment

Criteria	Value
Sail and a mast	0.33
Spare part of the engine	0.41
Extra fuel of the engine	0.26

Consistency Ratio Value (CR) = 0.046

The value of each criterion in the analysis results in the table is acceptable because the sensitivity test results obtained a value of CR = 0.046 where if the CR value <0.1 indicates a rational consistency ratio, it means that the respondent is very consistent in assessing each criterion. The value of each parameter indicates that engine spare parts (0.41) are the main factor as additional equipment in fishing vessel marine standards, followed by sails and masts (0.33), and extra fuel of the engine (0.26).

The high value of the criteria for engine spare parts in determining as a tool for fishing vessel marine eligibility standards in the additional equipment aspect is based on the respondent's choice. This is reasonable because the engine spare parts function to anticipate if there is damage to the ship's engine during the fishing process.

The next highest scores were sails and masts, and spare fuel. The choice of this respondent is also very supportive of fishing vessel additional equipment.

4. Conclusion

The seaworthiness assessment in Luwu Regency based on three parameters show that for the aspect of safety equipment, the ones with the highest weight are life jackets, life buoy, lifeboats, and fire extinguishers, respectively. Marine maps and Global Position Systems (GPS) achieve the highest weight for the navigation equipment aspect and for the auxiliary equipment aspect with the highest weight, i.e. engine parts.

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