# Utilizing The Analytic Hierarchy Process for Decision-Making in the Indonesian Marine Police: A Case Study in Hospital Ship Selection for Improved Security and Functional Capacity

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## Abstract

Within the Indonesian National Police, the marine police unit plays a critical role in the post-disaster context, providing vital assistance to communities affected by natural calamities, particularly those related to search and rescue operations (SAR). To carry out their duties effectively, the marine police must have access to suitable resources, including appropriate ships. Therefore, this study aims to identify alternative hospital ships that meet the criteria set by the marine police for their operations. To do this, the study uses the Analytical Hierarchy Process (AHP) method to determine the relative importance of each criterion used to evaluate potential alternatives. By utilizing the AHP method, the marine police can make informed decisions on the selection of hospital ships that will be used for their search and rescue operations. Ultimately, the goal of this study is to enhance the ability of the marine police to carry out their duties in protecting the safety and security of the Indonesian people. Once the calculations were completed based on the 4 established criteria and 13 sub-criteria, the most suitable option for the Hospital Ship for the marine police was determined and it is the ship 4 out of the other 4 alternatives.

## Keywords
Police, Hospital Ship, Ship Selection, AHP.

## 1. Introduction
Indonesia is an archipelagic country located at the confluence of four tectonic plates, including the Asian and Australian Continental Plates, the Indian Ocean Plate, and the Pacific Ocean. Southern and eastern parts of Indonesia consist of volcanic belts that stretch from Sumatra to Sulawesi and include old volcanic mountains and swamps. (BNPB n.d.). Indonesia's coastline spans 95,181 km, making it the world's second-longest coastline and comprising 71% of its entire territory with 17,504 islands, Indonesia is the world's largest archipelagic nation and depends heavily on its seas for survival (Indonesia n.d.). Under these conditions, Indonesia is vulnerable to natural disasters, such as volcanic eruptions, earthquakes, tsunamis, floods, and landslides. Indonesia has a high level of seismicity, more than ten times that of the United States, making it one of the world's most seismically active countries.

As is widely known, Indonesia is situated in an area known for its active volcanoes and tectonic plate faults, making it highly vulnerable to natural calamities like volcanic eruptions and earthquakes. Given this vulnerability, it is

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imperative to have a disaster mitigation plan in place to address the aftermath of these events. The National Disaster Management Agency (BNPB) has designed such a plan, which involves ship and dock infrastructure to facilitate evacuation processes. In the event of a volcanic eruption or earthquake, facilities on land are susceptible to destruction, making it necessary to have disaster mitigation by sea. This responsibility falls under the purview of the Marine Police Directorate (DITPOLAIR), whose primary task is to promote and carry out the functions of the Central Level Marine Police, to serve, protect, and maintain public security and order in Indonesian waters. The vision of DITPOLAIR is to create a Marine Police force that can help build public security and order in Indonesian waters and provide professional, modern, and reliable services, protection, and support to the public. To this end, DITPOLAIR's mission includes ensuring security and order in the waters, maintaining public order and providing legal certainty services, promoting community participation, providing assistance to natural disaster victims, ensuring shipping safety, and enhancing cross-sectoral and international cooperation.

However, at present, the support for disaster mitigation through sea-based facilities and infrastructure, which is the responsibility of DITPOLAIR, is not yet optimal due to the absence of a Hospital Assistance Vessel (KBRS). Currently, Indonesia only has three Indonesian Republic Warships (KRI) under the ownership of the Indonesian Navy that can function as Hospital Ship (KRS), namely KRI dr. Soeharso-990, KRI Semarang-594, KRI dr. Wahidin Sudirohusodo-991 and KRI dr. Radjiman Wedyodiningrat-992. The Hospital ship is mainly used as a support vessel during War Military Operations (OMP). In peacetime, hospital ships function in Military Operations Other Than War (OMSP) to provide aid in natural disasters, evacuation, and search and rescue operations. If there is no humanitarian mission, then the ship, as a part of KRI, mainly carries out technical maintenance and personnel training for KRI crews and medical personnel. Usually, these ships are docked at the base under the command of the main commander on duty. This indicates that there is a need for an additional KRS ship to support the existing infrastructure and facilities for disaster mitigation.

In the context of Indonesia's vulnerability to natural disasters, the Indonesian National Police (POLAIR) has a responsibility to assist victims in the aftermath of a disaster. To effectively fulfil this duty, POLAIR requires a fleet of ships that are appropriate and meet their specific criteria. This study aims to identify the optimal shipping option for POLAIR based on a comprehensive assessment of the agency's needs and requirements.

## 2. Literature Review

Among the dominant multi-criteria decision-making tools, the AHP, conceived by Saaty in the 1970s, holds a prominent position for its effectiveness in tackling intricate decision-making challenges (Saaty 1980). The AHP methodology has demonstrated its versatility in diverse arenas, including education, engineering, industrial processes, managerial decision-making, production optimization, political analysis, and sporting competition evaluation, and also aids in vehicular decision-making. (STARČEVIĆ, et al. 2019). The AHP method could also be used in the military section, such as when choosing a new warship (Santos, Costa and Gomes 2021). determine the location of military warehouses (YALÇIN and KARA 2022), and prioritization and selection of the most effective UAV (Hamurcu and Eren 2020).

The Directorate of Marine Police of the Marine and Air Police Corps of the National Police of the Republic of Indonesia, or commonly abbreviated as Ditpolair Korpolairud Baharkam Polri, is the main implementing unit of Korpolairud Baharkam Polri that is directly under the control of Kakorpolairud. The main tasks of DITPOLAIRUD are to foster and implement the functions of the Marine Police at the Central level in order to serve, protect, nurture, and maintain public order and security and law enforcement in the waters of Indonesia. The vision of DITPOLAIRUD is to realize the Marine Police as a builder of public order and security in the waters of Indonesia in order to provide professional, modern and trusted services, protection and guidance to the community. The missions owned by DITPOLAIRUD are as follows:

1. Guarantee security and order in the waters;
2. Maintain public order and provide legal certainty services;
3. Encourage community stakeholders to be more actively involved in realizing a prosperous community life;
4. Provide assistance to victims of natural disasters (SAR);
5. Assist marine safety;
6. Increase cross-sectoral and international cooperation.

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The Marine and Air Police Corps of the National Police of the Republic of Indonesia is a specialized unit of the Indonesian National Police that is responsible for maintaining public order and security, enforcing the law, and providing assistance to victims of natural disasters in the waters of Indonesia. The Marine and Air Police Corps has a wide range of capabilities, including:

- Patrol vessels: The Marine and Air Police Corps has a fleet of patrol vessels that are used to patrol the waters of Indonesia. The patrol vessels are equipped with a variety of weapons and equipment to deter and respond to criminal activity.
- Air assets: The Marine and Air Police Corps also has a fleet of air assets, including helicopters and fixed-wing aircraft. The air assets are used to provide support to the patrol vessels and to conduct search and rescue operations.
- Specialized units: The Marine and Air Police Corps has several specialized units, including the Diving Unit, the Explosives Ordnance Disposal Unit, and the Marine Police Intelligence Unit. These units are responsible for conducting specialized operations, such as underwater investigations and bomb disposal.

## 3. Methods

The concept of Multi-Criteria Decision Making (MCDM) was initially introduced by Zionts in 1979, and it has since been extensively utilized in various academic and industrial domains. Some of the applications of MCDM include vendor selection, purchase bids, construction safety assessment, and selection of promotion mix, all of which involve multiple evaluation criteria (Ma, et al. 2022). MCDM is a decision-making approach that identifies the best alternative from a set of available choices based on predetermined criteria, which could be standards, measures, or decision-making rules (Taherdoost and Madanchian 2023). There are two types of MCDM methods: singular MCDM methods and integrated MCDM methods. Singular MCDM methods are those that make decisions based on a single criterion, while integrated MCDM methods consider multiple criteria (Ma, et al. 2022). MCDM assesses the alternatives and ranks them from best to worst. The main steps of all MCDM problems are shown in Figure 1 (Mardani, et al. 2016) (Souza, et al. 2021).

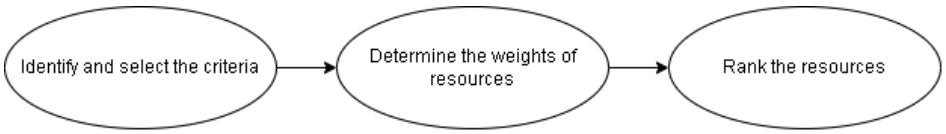


Figure 1. Steps of MCDM

The Analytic Hierarchy Process (AHP) is a decision-making technique that involves expert judgment and pairwise comparisons to determine priorities. It is a popular multi-criteria decision-making tool, widely used by researchers and decision-makers due to its simplicity and effectiveness (Saaty 1980). The AHP methodology was developed by Thomas L. Saaty to facilitate systematic decision-making and prioritization. Its hierarchical structure allows for the measurement and synthesis of various factors involved in a complex decision-making process. This structure enables the combination of different parts into a unified whole. As a result, the AHP methodology is widely used by decision-makers and researchers alike due to its ability to structure complexity, measure, and synthesize information (Russoa and Camanhob 2015).

Saaty is the developer of the Analytic Hierarchy Process (AHP), which was first used in the marketing industry in the late 1970s. The AHP methodology helps in organizing complex decision problems into hierarchical levels, making it easier to analyze and solve them effectively. (Schmidt, et al. 2015). Thomas L. Saaty developed AHP as a decision-making tool to support complex problems. AHP operates on the principle of organizing intricate multi-criteria or multi-factor issues into a hierarchy. Saaty defines hierarchy as a multi-level structure where the top level represents the goal, followed by levels for factors, criteria, sub-criteria, and so on, down to the last level, which is the alternative option to the problem. AHP can manage both subjective and quantitative elements, including dynamic cycles, systematically and efficiently. By breaking down a complex problem hierarchically, AHP creates a more structured and systematic approach, allowing for a quick and methodical analysis of the problem. (Ishak, Asfriyati and Nainggolan, Integration of Fuzzy AHP-VIKOR Methods in Multi Criteria Decision Making: Literature Review 2020). The stages of decision-making in the AHP method are basically as follows (Ishak and Wanli, Analysis of Fuzzy AHP-TOPSIS Methods in Multi Criteria Decision Making: Literature Review 2020), (Russoa and Camanhob 2015):

1. Define the problem and determine the solution or goal;
2. Create a decision hierarchy structure;

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3. A pairwise comparison matrix is created to describe the relative effect of each element on the level of objectives or criteria above it. Comparisons are made based on the choices or considerations of the decision maker by assessing the level of importance of an element compared to other elements;
4. Data normalization is done by dividing the value of each p element in the paired matrix by the total value of each column;
5. Repeat steps 3 to 5 for all levels of the hierarchy;
6. Calculate the eigenvector values (weight of each element) for each matrix pairwise comparison;
7. Test the consistency of the hierarchy. If it is not in accordance with CR <0.1 then the assessment must be repeated;
8. Decision-Making and Implementation.

## 4. Data Collection

The Marine and Air Police Corps is a highly capable and professional unit that plays a vital role in maintaining security and order in the waters of Indonesia.Four potential ship alternatives have been chosen for equipping military units involved in multinational operations worldwide. It's noteworthy that, in this instance, the vehicles will be labeled as "Vehicle 1," "Vehicle 2," "Vehicle 3," and "Vehicle 4" in accordance with prescribed safety and protection procedures, as well as data protection measures.

1. Ship 1: This ship is 122 meters long, 22 meters wide, and can draft 4.9 meters of water. When empty, it weighs 7,300 tons, but it can carry up to 2,480 tons of cargo (deadweight). Its total weight is 11,300 tons. The ship has a maximum speed of 13 knots, and its engine can reach 775 rotation per minute at full power and 500 rotation per minute at idle. It has an 8-cylinder in-line engine that produces 2,665 british horsepower. The ship can accommodate three types of Super Puma helicopters in its hangar and can stay at sea for up to 25 days.
2. Ship 2: This ship is 122 meters long, 22 meters wide, and can draft 4.9 meters of water. When empty, it weighs 7,294 tons, but it can carry up to 2,670 tons of cargo (deadweight). Its total weight is 10,932 tons. The ship has a maximum speed of 16 knots, and its engine can reach 775 rotation per minute at full power and 500 rotation per minute at idle. It has an 8-cylinder in-line engine that produces 2,665 british horsepower. The ship can accommodate three types of MI-2 helicopters and two types of Bell 412 helicopters in its hangar and can stay at sea for up to 30 days.
3. Ship 3: This ship is 125 meters long, 22 meters wide, and can draft 5.3 meters of water. When empty, it weighs 7,300 tons, but it can carry up to 2,800 tons of cargo (deadweight). Its total weight is 10,500 tons. The ship has a maximum speed of 16 knots, and its engine can reach 775 rotation per minute at full power and 500 rotation per minute at idle. It has an 8-cylinder in-line engine that produces 3000 british horsepower. The ship can accommodate five types of MI-2 helicopters and two types of Bell 412 helicopters in its 2 hangars and can stay at sea for up to 30 days.
4. Ship 4: This ship is 124 meters long, 21.8 meters wide, and can draft 5 meters of water. When empty, it weighs 7,726 tons, but it can carry up to 2,174 tons of cargo (deadweight). Its total weight is 11,320 tons. The ship has a maximum speed of 18 knots, and its engine can reach 1010 rotation per minute at full power and 500 rotation per minute at idle. It has an 16-cylinder in-line engine that produces 7268 british horsepower. The ship can accommodate three types of MI-2 helicopters in its hangar and can stay at sea for up to 30 days.

The process of collecting data is obtained to fulfil the information needed to achieve the objectives of the research being carried out. Data collection was carried out by giving questionnaires to experts in their fields and taking company data. The following is a profile of the questionnaire fillers.

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**Table 1.** Experts

| Rank | Position | Years of Service |
|---|---|---|
| Major | Technology Analysis Officer (Marine Police) | 18 |
| Major | Chief Engineer Officer (Navy Army) | 19 |
| Lieutenant Colonel | Chief Engineer Officer (Navy Army) | 18 |

Utilizing a literature review and expert consultations with the Ship Commander of the Directorate of Marine Police, this study delineated four primary criteria, thirteen sub-criteria, and four decision alternatives. Figure 1 visually depicts these elements.

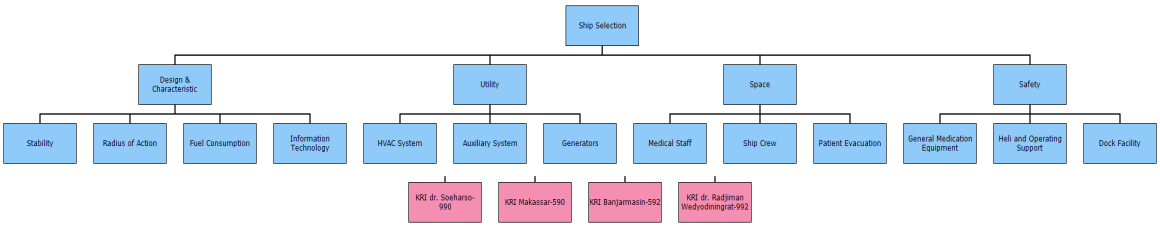


**Figure 2.** Goal, criteria, sub criteria, and alternatives

## 5. Results and Discussion

Among the four criteria evaluated and using AHP-OS (Online System) Business Performance Management Singapore (BPMSG) as the tools for AHP, "Design & Characteristics" holds the highest weight, as demonstrated by the findings below, with "Space," "Utility," and "Safety" ranking successively lower.

Decision Hierarchy

| Level 0 | Level 1 | Level 2 | Glb Prio. |
|---|---|---|---|
| Hospital Ship Selection | Design & Characteristic 0.357 | Stability 0.547 | 19.5% |
| | | Radius of Action 0.170 | 6.1% |
| | | Fuel Consumption 0.153 | 5.5% |
| | | IT 0.129 | 4.6% |
| | Utility 0.197 | HVAC System 0.234 | 4.6% |
| | | Auxiliary System 0.444 | 8.7% |
| | | Generators 0.322 | 6.3% |
| | Space 0.321 | Medical Staff 0.387 | 12.4% |
| | | Ship Crew 0.216 | 6.9% |
| | | Patient Evacuation 0.397 | 12.8% |
| | Safety 0.125 | General Medication Equipment 0.655 | 8.2% |
| | | Heli and Operating Support 0.234 | 2.9% |
| | | Dock Facility 0.111 | 1.4% |
| | | | 1.0 |

Figure 3. Weighted criteria and sub criteria

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**Table 2.** Average AHP Group Consensus Alternatives

| Experts | Ship 1 | Ship 2 | Ship 3 | Ship 4 | Crmax |
|---|---|---|---|---|---|
| Expert 1 | 19,2% | 22,5% | 15,9% | 42,4% | **4,1%** |
| Expert 2 | 15,8% | 12,0% | 25,6% | 46,6% | **3,8%** |
| Expert 3 | 26,2% | 11,6% | 11,6% | 50,6% | **2,2%** |
| **Group Result** | **20,7%** | **14,5%** | **17,1%** | **47,7%** | **2,3%** |

Following comprehensive evaluation through a weighted analysis, Ship 4 emerged as the most advantageous maritime asset amongst the considered alternatives with the value of (47,7%). ships 1 (20,7%), ship 3 (17,1%), and ship 2 (14,5%) followed in decreasing order of suitability.

## 6. Conclusion

Building upon the identified need for additional maritime evacuation capacity to support disaster mitigation efforts, this research employed Multi-Criteria Decision Making (MCDM) techniques to evaluate four potential hospital ship options for the Indonesian Marine Police Directorate (DITPOLAIR). Utilizing the Analytic Hierarchy Process (AHP) methodology, the study analyzed the ships based on pre-determined criteria and sub-criteria aligned with DITPOLAIR's mission and operational requirements. The analysis revealed that Ship 4 emerged as the most optimal choice with value 47.8%, demonstrating the highest overall score amongst the alternatives due to its superior cargo capacity, longer sea endurance, and ability to accommodate multiple helicopter types. This selection aligns with DITPOLAIR's objective of providing efficient and comprehensive disaster response capabilities during natural emergencies. Furthermore, the research highlights the critical role of MCDM tools in facilitating informed decision-making for complex public safety operations. The systematic evaluation framework employed in this study can be replicated for future ship acquisition processes within DITPOLAIR and other maritime safety agencies, ensuring mission-aligned investment in vital disaster response infrastructure.

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