Study of ambulance ship design for island services in Indonesia

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Abstract. Ambulance ships are one of the ships used to help transport the people who experience pain and are in the islands and are connected to the nearest regional General Hospital. The ship will be used in two concepts, namely the first to transport sick people or due to disasters and when ordinary days are used to transport passengers. This need is a consideration to reach areas that are quite difficult to reach. In this plan, the principal dimension is determined according to the area covered. Ships selected using Fibreglass material. The planning method uses a spiral design with ship planning procedures. The dimensions obtained are based on the results of calculations according to the function and usability of the ship. And the speed of the ship produced as well as the load space for passengers and sick people. This ambulance ship will be used according to the limits of the planning results.

1. Introduction
The number of islands in Indonesia is something unique. But behind the unique conditions faced with the problem of health services of the local government to the community caused by illness, disaster or the process of transporting victims of accidents. This incident certainly occurred in the archipelago and far from the General Hospital.

At present Transportation has a very vital contribution and has a strategic dimension for national development, because of its role as a driver and driver of development activities and as an adhesive between regional gaps. The strategic position of transportation between islands is increasingly felt important when many other sectors have a reduced role, while the role of transportation has turned out to be a central point for national conditions. Likewise, it is not inferior to ships that support life in every island in terms of health, such as on Ambulance ships.

To handle the movement of services through ships, especially ambulance ships as a means of transporting sick people, the operation of the ship is determined by the number of activities of the vessel in carrying out its activities. Furthermore, it is determined by the state of the sea and the limitation of operating hours for a day. Operation in this plan is carried out at a distance of approximately 28 miles and the speed of the ship is 24 knots which is then adjusted to the main engine used and the auxiliary engine operating during the movement of the ship.

2. Method
Spiral design is the application of the iterative concept, which aims to find a solution that meets all aspects in a balanced manner. A typical iteration like this is suitable for designing a ship where the main
size is not compiled by natural limits. In the case of an instant the cargo load is large enough to decide that the capacity of the vessel can be greater than the boundary arranged by factors such as water depth, and canal width, the correct procedure is to set size limits with maximum values and then balance with all aspects [1].

This description requires strong exposure from a variety of experienced designers, because the initial assumptions that are arranged by default from property requests are basically not recommended. Owner requests should not be decided to be used fully before all possible solutions that have been traced.

The stages of spiral design can be seen in the following illustration [2]:

![Figure 1. Spiral design.](image-url)

To design a ship in this design study there is methods of Comparison designing a ship based on theory and experience combined with one another. The design of ships using the comparative ship method is to use existing types of ships to get the basic concept of ship design that will be planned based on the characteristics of the local area. This method is used to speed up the spiral design process that starts planning from zero, so that the results obtained are expected to not be too long in a spiral process such as the scheme above [3].

3. Ship technical plan

Ships in general are a shape or vessel with thin walls, waterproof and filled with cargo, passengers, machinery and aboard the crew and ship equipment that is suitable for the purpose of its construction [4].

3.1. Type

The form of the hull is designed with the criteria of high-speed ships, including small block coefficients (0.5), standard and high-speed spaces and fulfilling seaworthy provisions, namely good ship stability, capable of sailing in any waters condition. On the basis of this, the design optimization is chosen as the "V" type hull [5].

3.2. Function

The General design image is one of the applications of the hull form with the upper deck / building designed to fulfill work facilities, namely as high-speed ambulance ships with operating areas in limited waters or offshore waters [6].

3.3. Constructions design

Scantling of ship construction is very much determined by the shipping area which affects the strength of the ship, if the price of a small L / D ratio will increase the longitudinal strength of the ship [7]. The construction design will also produce output in the form of construction drawings.

Fiberglass as the main material that will be used in the basic design of the design of high speed ship ambulance, in its selection will also pay attention to several provisions that have been set according to BKI regulations in 2006, the type of Fiberglass used for construction under the water line is a type of
Fiberglass that has a weight Fiberglass type (minimum) 700 kg / m³ with 15% humidity [8]. More details are presented below [9].

Type of Fiberglass used for construction above the water line is a type of Fiberglass which has a minimum specific gravity of 560 kg / m³ with 15% humidity. More details can be seen below [10].

Types of Fiberglass Used for Construction above the Water Line

| Type of Fiberglass | Weight (g/m²) |
|--------------------|---------------|
| Gelcoat (G)        | 500           |
| Chopped Strand Mat (M.300) | 300         |
| Double Biaxial (DB 800) | 800         |
| Unidirectional (UD 900) | 900         |
| Core               | T = 20 mm     |

3.4. *Ambulance high speed ship medical equipment*

Standard medical equipment for ambulance ships is one of the most important in the operation of high-speed ambulance ships designed to meet medical work facilities in operations.

- Oxygen Concentrator
- Airway, Guedel
- Ambu Bags
- Defibrilator
- Spinal Board
- Stretcher Folding Type
- Minor Procedure Light

4. *Main plan*

After paying attention to all the above aspects, the dimensions of the ship are determined according to the calculation of the comparison ship estimation as follows:

### 4.1. Main ship size:

- Length Over All (LOA) = 28.00 Meter
- Length Perpendicular (LPP) = 24.00 Meter
- Breadth Moulded (Bm) = 5.40 Meter
- Height of Ship (H) = 3.30 Meter
- Draft (T) = 1.15 Meter
- Block Coefficient (Cb) = 0.437

### 4.2. Ship weight component LWT and DWT

In this case the calculation of the weight of the ship using the approach formula and the method of calculating the weight components on the ship. Included in the light weight (LWT) are [11]:

- Machine and gearbox weight
- Weight of Shafting
- Weight of Propeller
- Weight equipment and Outfitting (E &O)
- Hull and superstructure weight

Whereas including Ship Deadweight (DWT) are:

- Crew weight and luggage
- Fuel Oil
- Fresh Water
4.3. Design process
After obtaining the main size of the ship, the next step is planning the hull of the ship, in making this hull using Maxsurf Pro software. For designing general arrangements and other key plan images using Auto CAD software. Whereas to find out the stability of this ship using Hidromax software. For calculation of ship resistance using Hullspeed software.

4.3.1. Curve Section Area (CSA)
Made from Maxsurf Pro.

4.3.2. Lines plan. In this design process, the shape of the hull is designed with a size that has been adjusted to the owner's needs by taking into account the existing aspects, namely the 3.30-meter hull height with 1.15 meters’ full design, 5.40 meters wide and 28.00 meters’ overall length [12].

5. Resistance
To calculate ship resistance, Hullspeed software is used, to see the results of design calculations can be done through the graph window (in the form of a graph) or a table window on the toolbar. Hullspeed will check that the data entered is in a valid range for the method to choose.

From the graph data above, we can see that with the selected engine marine specification that is with a power of 1150 hp (@ 2 x 1150 hp = 2310 hp can reach a maximum speed of 32,696 knots, the $F_n$ value is:

$$F_n = \frac{V}{\sqrt{gL}}$$

then:

- $V_s =$ Ship speed (m/dt)
- $g =$ Gravity (m/dt$^2$)
- $LWL =$ Length of Water Line (m)

$$V_s = 32,696 \times 0.5144 = 16,818 \text{ m/dt}$$
$$g = 9,810 \text{ m/dt}^2$$
$$LWL = 25.25 \text{ m}$$

$$F_n = 1.068$$

6. Propeller design
Propellers are a ship propulsion device that can produce thrust that exceeds the total resistance of the ship, so the ship can move at the planned speed. As a ship propulsion device, propeller working conditions are influenced by several factors such as; its working relationship with the hull of the ship, the effect of cavitation, the shape and size of the geometric of the propeller [13].

![Figure 2. Ship modelling from this research.](image-url)
To determine the propeller coefficient using the formula contained in the book principal naval architecture $B_p - \delta$, namely:

$$B_p = \frac{N_K \times \sqrt{SHP}}{V_a^{2.5}}$$

Where:

- $N_K$ = Turn the propeller after correction (Nm)
- SHP = Shaft Horse Power / $P$ (HP-British)
- $V_a$ = Advance speed of propeller (knot)

For planning this propeller using a comparison of several types of propeller type B, namely B4-40, B4-55, B4-70 and B4-85.

From the table of $B_p - \delta$ can be planned propeller that will be used in the design of this vehicle, thus the propeller specifications needed for driving this vehicle are as follows:

- Type propeller: B4-40
- Propeller diameter (D): 0.899 m
- Pitch Ratio propeller ($H_o/D$): 1.08
- Propeller efficiency ($\eta_p$): 73.8%
- Number of propeller blades (Z): 4

7. Gross tonnage calculation

Ships in their function as conveyances used in economic activities, the ship must be subject to taxes and require fees in connection with that activity.

To calculate the amount of the Gross Register Tonnage (GRT) the rules are used from Dirjen PERLA No. PY.67/1/13-90, that is:

$$GT = 0,25 \times V$$

$V$ = The amount of contents in the room below the deck is added to the spaces above the deck which are perfectly closed.

The total volume of a closed room is 331,039 m$^3$

Then the GT calculation is:

$$\begin{align*}
GT & = 0,25 \times V \\
& = 0,25 \times 331,039 \\
& = 82,76 \text{ m}^3
\end{align*}$$

8. Stability

To be able to guarantee the safety of the ship in its voyage, among others, the ship must have a stable balance or good stability. In this case the stability calculation is done by using application software as a simulation.

For Stability Analysis used 4 conditions, namely when the ship with conditions (Loadcase 1) at 100% full payload conditions, while for condition 2 (Loadcase 2) when the ship is in full passenger condition and 50% fuel and fresh water while for condition 3 (Loadcase 3) when the ship is in an empty passenger condition and fuel and fresh water are 20%. And for condition 4 (Loadcase 4) when the ship is in a condition without 0% load [14].

9. Ship material weight and total light weight

Calculation of the area and thickness of the layers obtained from the analysis of construction planning design that has been made.
The total hull weight and superstructure are as follows [15]:
Fiberglass Material Weight = 7.319 ton
Resin Material Weight = 14.461 ton+
Total = 21,780 ton

The total LWT component is as follows:
Machining Weight and GearBox = 4,198 ton
Weight of Shafting = 0.774 ton
Weight of Propeller = 0.153 ton
Equipment and Outfitting (E &O) = 2,030 ton
Another Weight = 10,120 ton
Hull and Superstructure weight = 21,780 ton+
Total = 39,055 ton

The total DWT components are as follows:
Crew weight and luggage = 3.51 ton
Fuel Oil = 9.91 ton
Fresh Water = 6.00 ton+
Total = 19.42 ton

Then the weight of the ship is:
\[ \Delta_l = \text{LWT} + \text{DWT} \]
\[ = 39,055 \text{ ton} + 19.42 \text{ Ton} \]
\[ = 58,475 \text{ Ton} \]

Figure 3. The results of the ambulance ship design study.

10. Conclusion
The ship has been planned to go through a design study and obtain a Dimension of Measure which according to the calculations falls into the design criteria required by theory and through the
classification bureau. Planning is carried out by determining water areas and operational areas with a defined distance of 28 miles considering the capacity of the fuel capacity on the ship to the total weight of the ship. The material used is determined to use Fiberglass on the basis of consideration of the cost and area of operation and investment in the procurement of the ship.

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