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Conversion of High Speed Landing Craft Boat for Passenger into High Speed Landing Craft Boat for Ambulance

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Abstract*— The Riau Archipelago is a province that geographically consists of 1700 islands surrounded by sea, both small and large, with a percentage of 98% sea and 2% land. Unfortunately, with thousands of islands in the Riau Archipelago Province, health facilities are not evenly distributed across all of these islands. So, to support the lack of health facilities in the Riau Archipelago, an Ambulance Ship is needed to mobilize patients to hospitals that have better facilities. This study aims to modify the design of the Passenger Fast Landing Ship into an Ambulance Ship with a length of 12 m, a width of 3 m, a height of 1.2 m, a draft of 0.6 m and calculate the resistance, power, stability and Motion Sickness Incidence (MSI) values. The research method used in this study is a computational simulation method with fixed parameters being the design of the ship's hull and speed; while the modified parameters are the ship's space and it's loaded. The results of this study were obtained for the comfort of patients and passengers, ambulance boats are designed for speeds service of 25-30 knots. So the resistance is 18191.19 - 18981.49 N at that speed, with a power engine requirement of 348.604 - 436.499 HP. From MSI analysis with ISO 2631 parameters, the wave heading is divided into 5 sections: 0^0 (Following Seas), 45^0 (Stern Quartering Seas), 90^0 (Beam Seas), 135^0 (Bow Quartering Seas), and 180^0 (Head Seas). The value MSI is obtained after carrying out a comprehensive analysis, the results are depicted in the MSI chart for sea state 1 calm (0-0.1 m) and sea state 2 smooth (0.1-0.5 m) conditions with the following wave directions, waves coming from the side (beam seas), and waves coming from the front (head seas).

Keywords— Ambulance Boat, Resistance, Power, MSI, Seakeeping

I. Introduction

The Riau Archipelago is one of the provinces which, when viewed geographically, the Riau Archipelago consists of various islands surrounded by oceans, both small and large islands. Riau Archipelago is a province in Indonesia located in the north-eastern region of Sumatra. This province consists of more than 1,700 islands, with the capital being in Tanjungpinang City. The Riau Archipelago is bordered by neighbouring countries such as Vietnam, Cambodia and Singapore, and has strategic waters because it is located in the Malacca Strait and the Natuna Sea. This province has abundant natural wealth such as beautiful beaches, coral reefs, and tropical forests. The Riau Archipelago is also known as the centre of the fishing, agriculture, mining [1], [2], [3].

On large islands, public facilities in the health sector such as hospitals and mobility support equipment such as ambulances tend to be advanced and implemented on adequate land, which is different for residents on small islands, infrastructure and transportation are very minimal when compared to large islands, even must enable them to mobilize to other islands to obtain proper infrastructure facilities, one of which is a hospital. Then another obstacle is the distance to the island and the long travel time in the event of an emergency, so this Ambulance Ship is suitable as a solution for fast patient mobility. In the Riau Archipelago, one of them is Benan Village, located in Lingga district, consisting of 2 Backwoods, 5 citizens and 9 neighbourhoods. Benan Village has 1 auxiliary health centre, with 1 midwife and 2 nurses as well as health workers; there is no hospital and only one ambulance [4]. The lack of health facilities is not evenly distributed across the islands in the Riau Archipelago. So, to support health facilities in Benan Village, an Ambulance Boat is needed, which can be obtained from boat modifications. Several previous studies have been conducted to create health facilities in the form of ambulance boats. They mostly use single hull high speed craft [5], [6], [7], catamaran high speed craft [8] and Amphibious High Speed craft [9].

In this research used the pre-conversion ship, the High Speed Landing Craft Boat, carrying a cargo of 24 passengers and light vehicles. The ship was converted into an Ambulance Boat carrying a cargo of 2 patients, 12 people including health personnel, and light vehicles. There are several additional modifications, including the division of the room plan and the cabin on the ship.

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These include patient rooms, health personnel, accompanying families, oxygen tubes, and emergency medicines. The concept of High Speed Landing Craft Boat converted into an Ambulance Boat is thought to be able to help facilities and health facilities in the village of Benan.

Planning the design speed with two 300 HP engines will get an estimated services speed of 25-30 knots, which is already eligible for a high-speed Craft ship's minimum speed of not less than V=7.19 ∇1/6 knots in Lloyd's Register Rules and Regulations, Part.2 [10]. The maximum safe speed shall be determined taking into account the limitations, the possibility of failure of one of the lifting or propulsion systems in quiet and dynamic water and on other surfaces, on a ship, Volume 3, section 4 [11]. On the Ambulance Boat design is the determination of the payload of the ship based on the size of the medical compartment of the reference ship, then obtained a payload in the form of a layer that is used to determine the division of the room and the ship plan. Technical calculations are then carried out that include obstacles, engine power, weight, freeboard, and stability.

II. METHOD

Divisions of sub-sections in results and the main sizes of the vessels to be used as the basic reference benchmarks for the design of the Lines Plan and the General Arrangement High Speed Landing Craft Boat [12] to be converted into an Ambulance Boat are as table 1. After the primary size of the ship is obtained, then the ship's Lines Plan is created that is adjusted to the main size data of the comparative ship to which the reference is taken as the data of primary sizes of the vessel and from the General Arrangement image listed. At the time of the design process of the ship conversion does not change the shape of the hull and deck. Changes have been made in the boat and shipyards. In designing Lines Plan High Speed Landing Craft Boat, which is then converted to Ambulance Boat, a good understanding of the principle of hydrodynamics is required to ensure that the ship has optimal and safe performance when sailing in different waters. Here are the fixed parameters and the planned variable parameters; fixed parameters are design of hull and the speed; and then the modified parameter is the ship room and loaded. Then in this study the data processing phase is as follows:

1) Creating 3D models using MaxSurf Software using lines plan as a reference.
2) The size of the hull model of the ship before and after the conversion is the same, as there is no change in the hull, but there may be changes in the hydrostatic data values in the ship design model.
3) MaxSurf 3D models were analyzed using MaxSurf Motion, Resistance, and Stability software.

Then the RAO (Response Amplitude Operator) is the reaction of a ship to a regular wave. RAO graph is a comparison between the amplitude of the ship movement (translation or rotation) with the wave amplitude at a certain frequency [13].

$$RAO = \frac{Z_0}{\zeta_0} \ (m/m) \quad (1)$$

$$RAO = \frac{\theta_0}{kw\,\zeta_0} = \frac{\theta_0}{(w^2/g)\zeta_0} \ (rad/rad) \quad (2)$$

In analysing movements using Motion Sickness

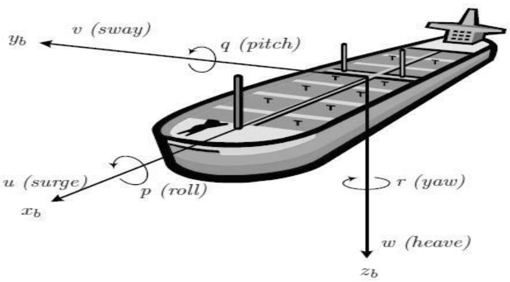

Figure. 1. Six Degree of Freedom

TABLE 1.
PRINCIPAL DIMENSION

Dimension	High Speed Landing Craft Boat (meter)	Ambulance Boat (meter)
LOA	12	12
Breath	3	3
Depth	1.2	1.2
Draft	0.6	0.6

Incidence (MSI) with ISO 2631, because MSI ISO 2631 is appropriate to use to analyze the safety/comfort of a ship, as explained in the research [14], [15], [16]. In analysing the movement of the vessel using five waves heading that represents the direction of wave when taking the body of a ship when operating in the sea 0^0 (following seas), 45^0 (stern quartering seas), 90^0 (Beam Seas), 135^0 (bow quartering sea), 180^0 (head seas). As we all know from figure 1, when a ship is operating or sailing, the ship will be affected by external forces, including: Sway, Pitch, Roll, Heave, Yaw, and Surge [17]. The speed limit to be analysed at the maximum operating speed is 30 knots. The vessels are planned to sail from the island to the island that is mainly located in the Riau Islands region, so that the wave height is adjusted to the water area with an average wavelength of only 0.1 meters in the waters around the Riau islands. Based on data from the Ocean Wave Forecasting System (OFS) issued by the Agency for Meteorology, Climatology, and Geophysics [18], the water conditions around the Riau Islands, especially in the Batam and Bintan areas, can be described as follows:

1) *The wave height*: Wave heights in the waters of Batam - Bintan range from 0.5 to 2 meters, with the highest height in the morning until afternoon.
2) *Direction of wave;* the wave direction in the waters of the Batam tends to vary, but mostly leads southwest to north; the wave direction in the waters of Bintan tends to vary, but mostly leads south to northwest.
3) The wind speed: Wind speeds in Batam waters range from 5 to 20 knots (9.26 to 37 km/h), with the highest speed in the afternoon to the night; Wind speeds in the waters of Bintan range from 5 to 15 knots (9.26 to 27.78 km/h), with the highest speed in the afternoon until night.

From the data, it can be concluded that the waters around the Riau Islands especially in the Batam and Bintan areas are generally safe enough to be active in the sea. However, it is still recommended to always pay attention to the current weather conditions and waves.

III. Results and Discussion

The results of 3D modeling on the ship's hull obtained from the conversion of High Speed Landing Craft Boat into Ambulance Boat, namely in the form of hydrostatic data that can be seen as a preference for the need to input the analysis parameters of the ship. Especially in calculating ship stability, load capacity, ship speed and other performance (see table 2).

The analysis of the movement of the ship was carried out in the Maxsurf Motion Software and obtained results in the form of graphs and tables. The International Towing Tank Conference (ITTC) is an organization that provides recommended procedures and guidelines for the design, construction, and testing of ships and marine structures.

One of the analysis methods recommended by ITTC is the ITTC method to predict the delivered power and rotation rate for single and twin scooters from the model test. The ITTC method is based on the assumption that ship barriers can be divided into two components: friction barriers and residual barriers. The friction barrier is equivalent to the surface area of the moist stomach, while the remaining obstacle is equal to the speed square. The transmission power required to move a ship at a certain speed can be calculated as the sum of these two components [19]. In short, ITTC is an organization that provides recommended procedures and guidelines for ship design and testing. The ITTC method is an analytical method recommended by ITTC to predict the given power and rotation rate for single and twin scooters from the model test.

The ITTC guidelines provide detailed instructions on how to perform model testing to determine various hydrodynamic characteristics of ships. After carrying out a comprehensive analysis, the results are depicted in the

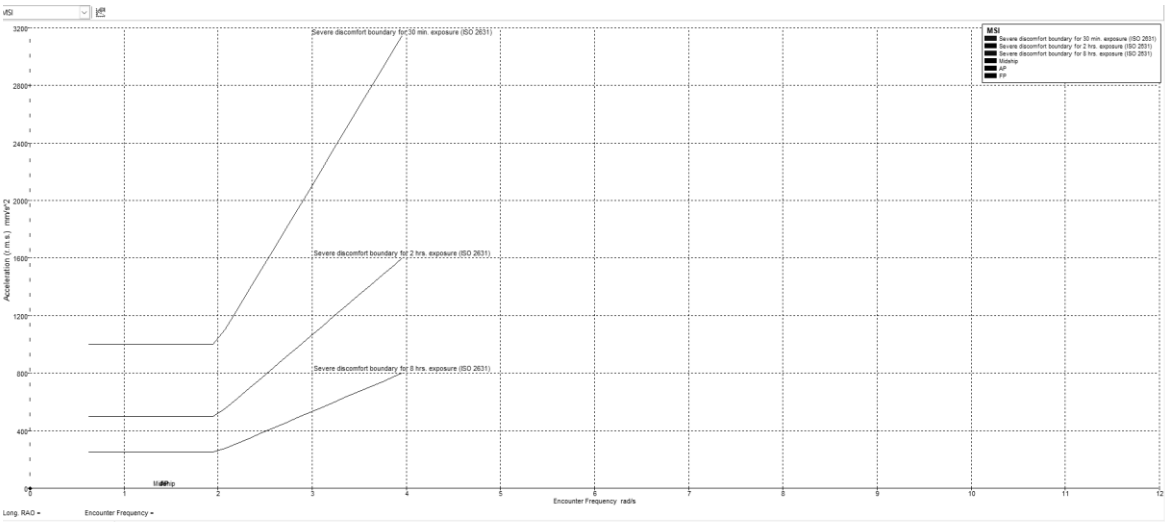

Figure. 2. MSI Discomfort Boundary

MSI chart (see figure 1) for sea state 1 (90^0) calm 0-0.1 m and sea state 2 (180^0) smooth 0.1-0.5 m conditions with the following wave directions, waves coming from the side (beam seas), and waves coming from the front (head seas).

From the MSI analysis with ISO 2631 parameters, it was found that the ambulance ship was considered comfortable to operate at a wave height of 2.5 m to 4 m (sea state 5) considering 2 hours of sailing and was considered comfortable to operate at a wave height of 4 m to 6 m (sea state 6) considering 30 minutes of sailing.

This statement is also reinforced by his previous research that the length of passenger comfort on the ship is 2.5 - 4 meters for 2 hours of sailing (see figure 2). These results provide important insights into the response and stability of the modified Ambulance Boat to different sea conditions, so that it becomes an important basis for ensuring the reliability and performance of the ship in operation [20].

However, when exposed to a 90-degree wave, MSI occurs in 10% of passengers after 2 hours, with all points longitudinally in the main landing, which occurs at Encounter Frequency 0.895 – 1.390 rad/s (see figure 3). When the ship moves against the wave (180 degrees) in moderate water and rough water conditions, there will be a tendency of 10% of passengers at the entire measurement position to experience sea drunkenness after a 2-hour cruise period, which occurs at encounter 1,555 rad/s. The results of this test are reinforced by previous research, thus making researchers confident about the flow that has been carried out [21].

TABLE 2.
HYDROSTATIC DATA

Measurement	Value	Units
Displacement	13,63	t
Volume (displaced)	13,295	m^3
Draft Amidships	0,600	m
Immersed depth	0,600	m
WL Length	11,040	m
Beam max extents on WL	3,000	m
Wetted Area	72,636	m^2
Max sect. area	1,519	m^2
Waterpl. Area	12,084	m^2
Prismatic coeff. (Cp)	0,793	
Block coeff. (Cb)	0,669	
Max Sect. area coeff. (Cm)	0,844	
Waterpl. area coeff. (Cwp)	0,365	
LCB length	4,920	from zero pt. (+ve fwd) m
LCF length	3,337	from zero pt. (+ve fwd) m
LCB %	44,568	from zero pt. (+ve fwd) % Lwl
LCF %	30,224	from zero pt. (+ve fwd) % Lwl
KB	0,321	m
KG fluid	0,000	m
BMt	0,633	m
BML	11,131	m
GMt corrected	0,953	m
GML	11,451	m
KMt	0,953	m
KML	11,451	m
Immersion (TPc)	0,124	tonne/cm
MTc	0,142	tonne.m
RM at 1deg = GMt.Disp.sin(1)	0,227	tonne.m
Length:Beam ratio	3,680	
Beam:Draft ratio	5,000	
Length:Vol^0.333 ratio	4,660	
Precision	Highest	212 stations

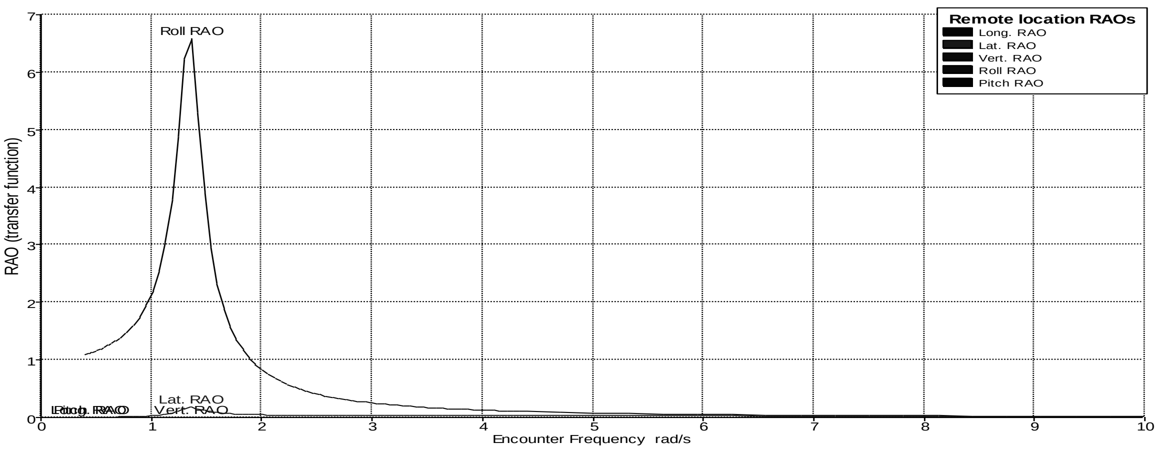

Figure. 3. MAX, 37kn; Beam Seas, 90 deg

The captive analysis was carried out in Maxsurf Resistance Software and results were obtained in graphs and tables. The output is graphic data that shows the size of the ship's resistance, power needs and so on [22]. Before entering the previous data, the Froude Number on the ship was calculated and the service speed of 37 knots was estimated (see figure 4 and 5). In this study, for the comfort of patients and passengers, ambulance boats are designed for speeds service of 25-30 knots. So, the resistance is 18191.19-18981.49 at that speed, with a power engine requirement of 348.604-436.499. The concept of High Speed Landing Craft Boat converted into an Ambulance Boat is thought to be able to help facilities and health facilities in the village of Benan. Planning the design speed with two 300 HP engines will get an estimated maximum speed of 25-30 knots, which is already eligible for a high-speed Craft ship's minimum speed of not less than V=7.19 ∇1/6 knots in Lloyd's Register Rules and Regulations, Part. 2.

The maximum safe speed shall be determined taking into account the limitations, the possibility of failure of one of the lifting or propulsion systems in quiet and dynamic water and on other surfaces, on a ship, Volume 3, section 4. On the Ambulance Boat design is the determination of the payload of the ship based on the size of the medical compartment of the reference ship, then obtained a payload in the form of a layer that is used to determine the division of the room and the ship plan. Technical calculations are then carried out that include obstacles, engine power, weight, freeboard, and stability. The stability analysis of the ship was carried out in the Maxsurf Stability Software and results were obtained in the form of graphs (see figure 6 & 7).

Following is the final design of the ship's interior plan in fully functional condition and General Arrangement of the ship after being converted into an Ambulance Boat type ship (see figure 8 & 9). Ambulance boat has standard specifications of the tools in it including: design of safety equipment; life boat planning; buoy planning; life jacket planning; fire

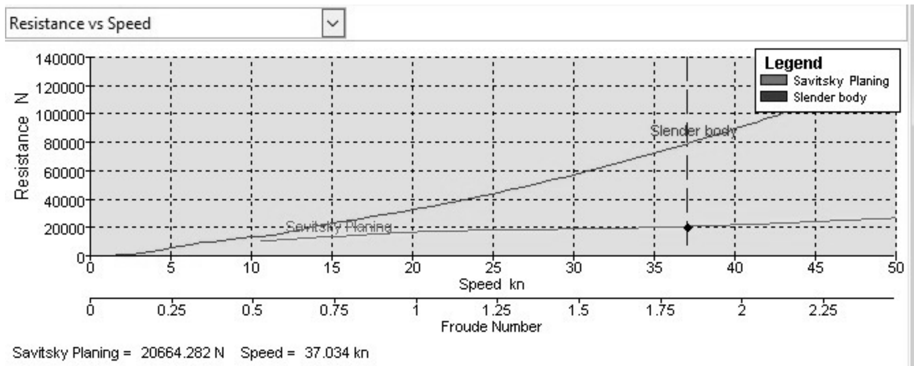

Figure. 4. Resistance vs Speed

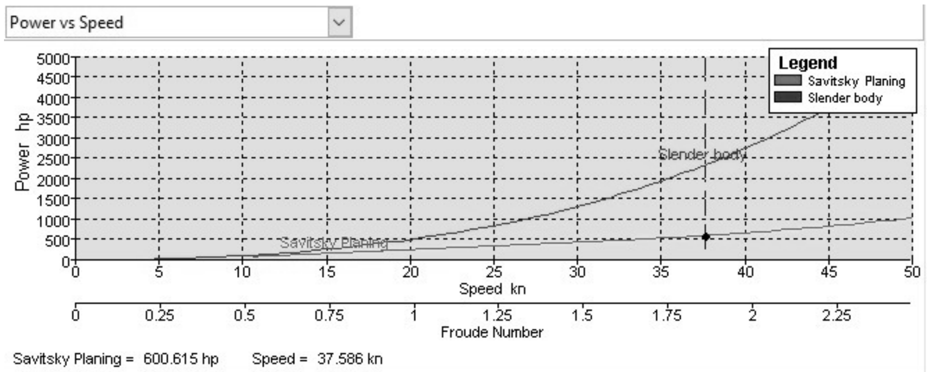

Figure. 5. Power vs Speed

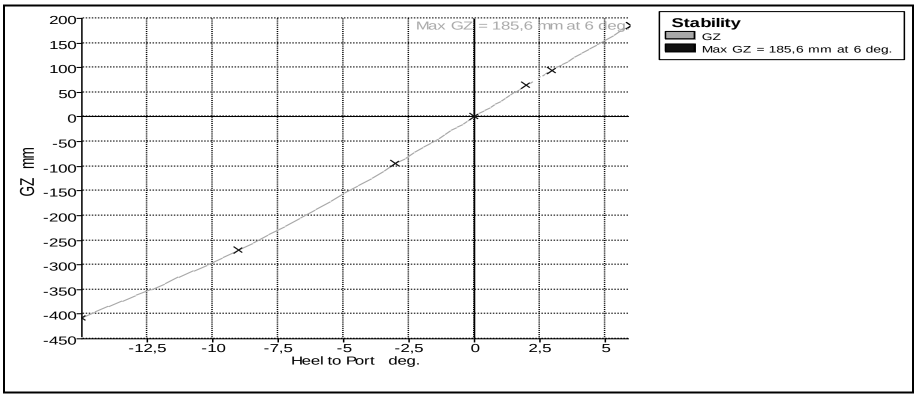

Figure. 6. GZ Stability Index

protection planning; detection tool; smoke detectors; infrared flame detector; heat detectors; warning device (alarm); fire extinguishers; bed patient; when brought aboard; toilet room; a place for urinating and defecating on the ship; examination room; patient examination room.

Conversion of high-speed craft passenger vessels into high speed craft ambulances has great potential for improving medical emergency response and providing efficient evacuation services in water areas. However, this process must be done carefully and ensure that the ship and crew have met the necessary safety and medical standards.

In addition, the benefits of converting a passenger ship into an ambulance ship include increased ability to respond to medical emergencies quickly and efficiently, thereby saving the lives and health of patients in emergency situations in hard-to-reach waters.

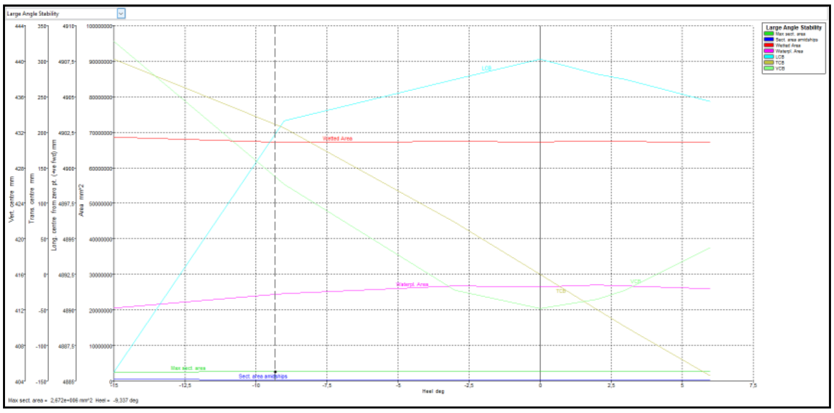

Figure. 7. Large Angle Stability Index

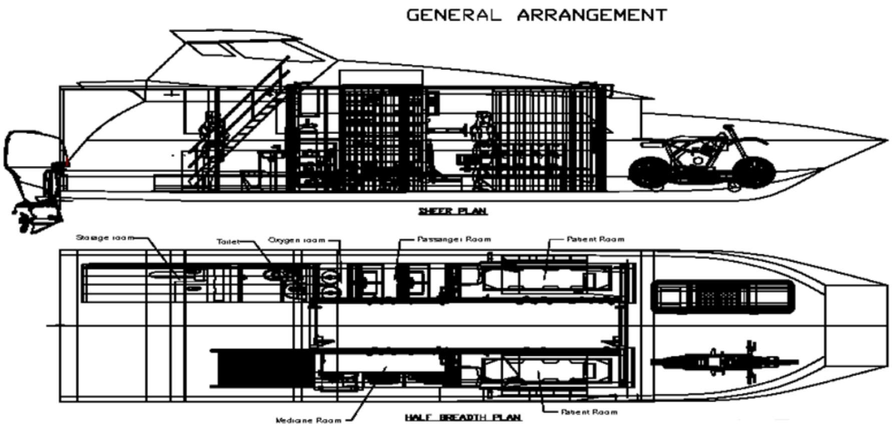

Figure. 8. General Arrangement Ambulance Boat

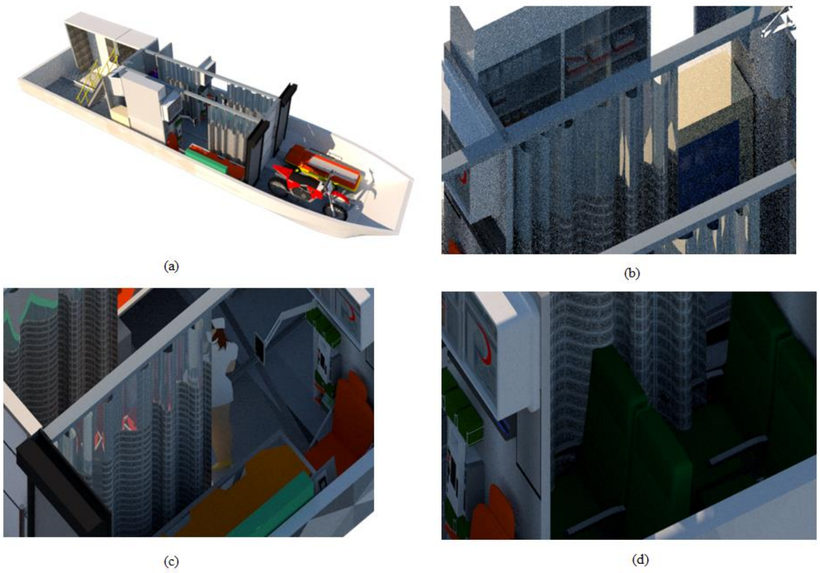

Figure. 9. Ambulance Boat. (a) Interior Design, (b) Medicine Room, (c) Patient Room, (d) Passenger Room

IV. Conclusion

From the results of research on Conversion of High Speed Landing Craft Boats into Ambulance Boats as an innovative solution for Riau Islands health services, the value MSI is obtained for sea state 1 calm (0-0.1 m) and sea state 2 smooth (0.1-0.5 m) conditions with the following wave directions, waves coming from the side (beam seas), and waves coming from the front (head seas). The results of the analysis of ship resistance on the ambulance boat are quite good between 18191.19 - 18981.49 N and with a power engine requirement of 348.604 - 436.499 HP. So, the ship can operate properly using 2 x 300 HP outboard motors with a predetermined service speed. Then, by maximizing the function of the existing space on the ship, it produces several rooms that are very efficient to use according to their function. This is done to support emergencies in remote areas, where patients are then taken to the nearest and most appropriate hospital or health facility.

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