Patrol Ship Design to Guard the Natuna Seas

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***Abstract*— Natuna is one of the regencies in the Riau Archipelago Province, the area of Natuna Regency is 224,684.59 km^2 with a land area of 2,000.85 km^2 and an ocean area of 222,683.74 km^2. According to the Ministry of Maritime Affairs and Fisheries, Natuna occupies the first position for the purpose of exporting fishery products from the SKPT location (Integrated Marine and Fishery Centers in Small Islands and Border Areas), namely marine fisheries resources reaching more than 1 million tons per year. The extent of Natuna waters and the large potential of existing capture fisheries resources cause the Natuna waters to be included in the Fisheries Management Area (WPP 711) which is prone to illegal fishing activities. It has been proven recently that in the waters of North Natuna there are coast guard ships from foreign countries escorting fishing vessels belonging to their countries that are carrying out illegal, unreported, and unregulated fishing activities. The purpose of this research is to design a patrol ship to carry out security missions around the Natuna waters. The method used in this design is the Parent Design Approach method. This method is known in designing ships, namely by taking a comparison ship that has the same characteristics as the ship to be designed. The main dimensions of the ship obtained in this final project are Lwl = 50.2 m, B = 9.32 m, H = 4.45 m, T = 3.5 m, Vs (max) = 25 Knots, Crew = 40 Indonesian navy. Armaments used on this ship are Oto-Melara 76/62SR 76 mm, Oerlikon Millennium 35 mm, RWS Machine Gun, and SS1-V1 Kal hand rifle. 5.56 mm.**

Keywords— Armament, natuna island, patrol ship, ship design, water safety.

I. INTRODUCTION

Natuna is one of the regencies in the Riau Islands Province, the area of Natuna Regency is 224,684.59 km^2 with a land area of 2,000.85 km^2 and an ocean area of 222,683.74 km^2 [1]. The capital city of Natuna Regency is Ranai City. Natuna is the northernmost archipelago in the Karimata Strait. To the north, Natuna is bordered by Vietnam and Cambodia, to the south by South Sumatra and Jambi, to the west by Singapore, Malaysia, Riau and to the east by East Malaysia and West Kalimantan. Natuna is on the international shipping lanes of Hong Kong, Japan, South Korea and Taiwan [1].

According to the Ministry of Maritime Affairs and Fisheries, Natuna occupies the first position for the purpose of exporting fishery products from the SKPT (Sentra Kelautan dan Perikanan Terpadu) location (Integrated Marine and Fishery Centers in Small Islands and Border Areas). Natuna is also famous for its prima donna fish such as Grouper and Napoleon. These two fish are the mainstay of export commodities to Hong Kong and China. The price of fish is priced at IDR 1 million per head with a weight of 9 ounces [2].

The extent of Natuna waters and the large potential of existing capture fisheries resources cause the Natuna waters to be included in the Fisheries Management Area (WPP 711) which is prone to illegal fishing activities. WPP 711 is waters that have borders with several neighboring countries such as Malaysia, Singapore, Vietnam and China. This abundant potential of capture fisheries resources has in fact invited various foreign ships illegally to utilize the Natuna Sea fishery resources. It has been proven recently that Coast Guard vessels from other countries are escorting fishing vessels belonging to their countries that are carrying out illegal, unreported, and unregulated fishing [3]. The Indonesian Ministry of Foreign Affairs has sent a protest note to the country's government. However, through a spokesman for the Ministry of Foreign Affairs stated that his party has the right to these waters by stating the historical reason that these waters have long been a place for fishing boats belonging to their state to operate [4]. The Indonesian government again protested by rejecting China's claim that it had rights over the waters in the region. The Indonesian government stated that China's claim was unilateral, had no legal basis, and was not recognized by applicable international law, namely the 1982 United Nations Convention for the Law of the Sea [4]. The Indonesian government again protested by rejecting China's claim that it had rights over the waters in the region. The Indonesian government stated that China's claim was unilateral, had no legal basis, and was not recognized by applicable international law, namely the 1982 United Nations Convention for the Law of the Sea [4]. The Indonesian government again protested by rejecting China's claim that it had rights over the waters in the region. The Indonesian government stated that China's claim was unilateral, had no legal basis, and was not recognized by applicable international law, namely

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the 1982 United Nations Convention for the Law of the Sea [4].

The incident explained that territorial sovereignty is a very sensitive issue. No country is willing to lose an inch of its territory. Therefore, the border issue cannot be ignored. Border issues have the potential to cause conflict. It is necessary to increase supervision over the sovereignty of one country to another [4].

With the existing problems, the existence of the Natuna Sea should be guarded by a fleet of patrol ship that are specifically settled in the area, so that the ship can operate optimally in order to improve better security.

II. METHOD

There are many methods used in the ship design process. The most commonly used are the spiral design method [5] and the Parent design approach. However, this research uses the Parent design approach method, which is to take one existing data of the ship to serve as a reference for comparison ship and have the same characteristics as the ship to be designed. The main size data of the ship that is used as a reference is the ship "DAMEN STAN PATROL 5009". The ship is chosen as a reference because this ship has an innovative hull shape that is different from other patrol ship in Indonesia, this ship has an Ax Bow-shaped front hull (FP) shape. The choice of the shape of the ax bow hull compared to the conventional bow type is based on other studies which conclude that changing the conventional bow hull design to the ax bow type on a 60 m patrol ship can reduce the amount of resistance by 2.75% [5].

III. RESULTS AND DISCUSSION

The Ship Patrol design process begins with determining the main size of the ship, determining the weapons on the ship, determining the payload, and patrol area, preliminary calculations of ship design, planning line plans, calculating resistance, and finally planning general plans. The complete research results can be seen below.

A. Determination of the Main Size of the Ship

Determining the main size in this final project, the author uses the parent design method with the same main size as the ship "DAMEN STAN PATROL 5009". This is done by the author because the ship has an innovative hull shape that is different from other patrol ship, namely the Ax Bow shape.

Here are the main dimensions of the designed ship:

Length Overall (LOA)	= 50.2 m
Breadth (B)	= 9.32 m
Depth (H)	= 4.45 m
Draft (T)	= 3.50 m
Ship Velocity (Vs)	= 25 Kn

From the main dimensions above, it will be used for making ship designs on the Maxsurf modeler software.

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B. Determination of Armament on Ship

Ship patrol is a type of warship that requires weapons that can give a trepidation effect to other ships that try to disturb or violate the territory of a country. For weaponry in this patrol ship design, it is based on the type of weaponry that has generally been installed on warships in Indonesia, as for the types of weaponry on this ship.

1. Otto-Melara 76/62SR 76 mm

The Oto Melara 76 mm cannon is considered as a cannon that is widely used as the main cannon in various types of warships, the cannon was produced by the Italian Otobreda company, although it has a caliber that is not so large but is reliable, so it is widely trusted by warship manufacturers in the world. world to be installed on their production warships, ranging from patrol ship, and corvettes to frigates [7].

Picture. 1. Damen Stan Patrol 5009 [6].

The Oto Melara 76 mm cannon is capable of firing at high speed (rapid fire) making it suitable for use as a cannon to repel air attacks, both in the form of guided missiles as well as airplanes and helicopters. With a caliber of 76 mm, it is also capable of being used as an anti-ship cannon. The ammunition used by this cannon consists of various types, including armor-piercing, incendiary, directed fragmentation, and others, while the range of fire depends on the angle of the shot. and ammunition material used, but in general, the shooting range can reach between 5,000 meters to 20,000 meters [7].

Specifications of OTO Melara 76 mm (76/62) Super Rapid Gun:

a. Rate of Fire: 120 rounds per minute
b. Empty weight: 7,900 kg
c. Barrel elevation angle: -15 to 85 degrees
d. Dome rotating speed: 35 – 60 degrees per second
e. Electrical supply: 440V, 3 phase, 60Hz, main circuit 115V, I-phase, 400Mhz, servo, and synchro network.

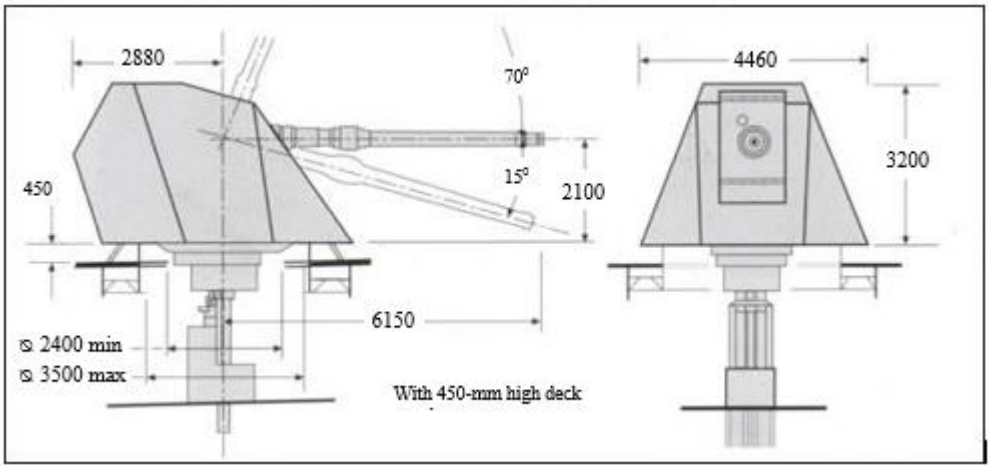

Figure. 2. Detailed Size of Otto-Melara [7].

2. Oerlikon Millennium 35 mm

This weapon relies on the Oerlikon Contraves 35/1000 caliber 35 mm L79 GDF-007 cannon with a gas mechanism and a water cooler. This canon is predicted to be able to bulldoze targets in the form of helicopters, low-flying fighter jets, to cruise missiles. Because it is installed on a warship vehicle, Millennium is set for three main roles. First, short target warfare to support friendly amphibious landing troops and suppress the threat of coastal defense forces. Then surface warfare, namely overcoming asymmetrical threats around littoral waters and law enforcement in the oceans. And the third is anti-air warfare, which is to neutralize threats from fighter planes, drones, and from enemy artillery systems when ships dock. The armaments used on this ship are Otto-Melara 76/62SR 76 mm, Oerlikon Millennium 35 mm, RWS Machine Gun, and Handgun SS1-V1 Cal. 5.56 mm [8]. Rheinmetall guarantees that the 35 mm ammunition fired from the barrel is capable of hitting small, fast-moving targets such as jetskis. Even if necessary the periscope of the emerging submarine can be bulldozed. All of that is not without reason, because Millennium is equipped with the latest stabilization system on the Canon mount, as well as a ballistic computer that is able to compensate for the tilt, shock, ship direction, wind speed, and others.

In theory, Skyshield is capable of intercepting enemy missiles at a distance of one to three kilometers. With a single magazine consisting of 252 rounds, this cannon is designed to be able to repel 10 missiles or aircraft that pass at high speed [8].

The Millennium sensor unit provides search, acquisition, tracking, and target tracking capabilities, then sends it to the fire control system to provide a firing solution based on a number of parameter data generated by the sensor unit. The installed system consists of a search radar, tracking radar, and electro-optic sensors to track targets. The search radar is square in shape and operates in the i-band in the 8.6 – 9.5 GHz frequency, rotates at a speed of 40 times per minute and has a 2D or 3D tracking wave mode [8].

Product Specification Oerlikon Millennium 35 mm

a. Control system: Remote/DC Servo
b. Fire Speed: 1000 projectiles per minute
c. Projectile Speed: 1,440 meters per second
d. Effective Range: 4,000 meters
e. Weight: 5500 kg
f. Length: 4.110 mm
g. Barrel elevation angle: -15 to 85 degrees

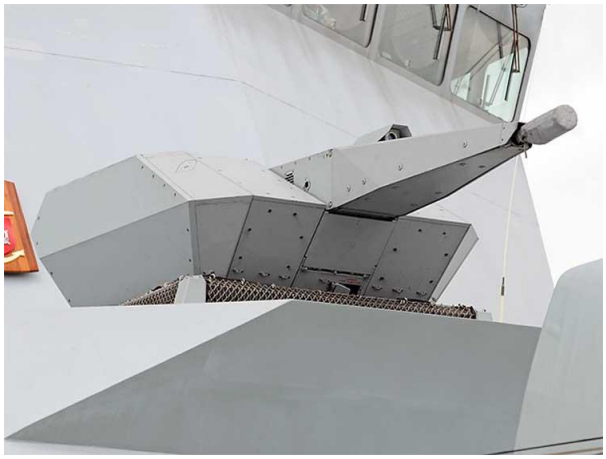

Figure. 3. Oerlikon Millennium 35 mm [8].

3. RWS Machine Gun

The weapon is used to deal with low-intensity maritime threats such as combat swimmers, pirates, and terror attacks and is very often used to provide warning fire at the enemy. A large battleship usually has 5-10 places for machine guns and a smaller ship has 2-4 guns.

RWS Machine Gun Specifications [9]

- 12.7mm M2 Machine Gun
- 7.62mm Machine Gun
- 40 mm MK19 Mod 3 Automatic Grenade Launcher
- Weight: < 250 kg (without gun and ammunition)
- Weight (Under Deck): < 70 kg
- Elevation: -15° / +55°
- Azimuth: nx 360° (with Slip Ring)

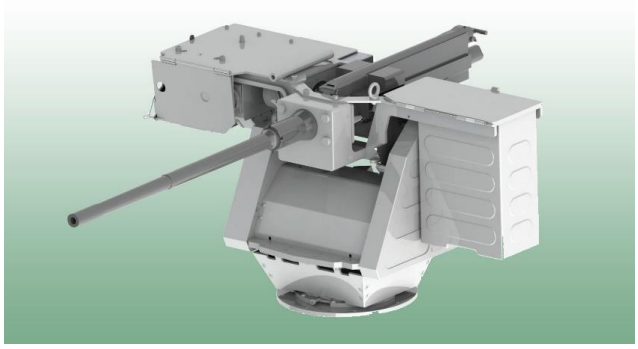

Figure. 4. RWS Machine Gun [9].

4. Hand rifle SS1-V1 Cal. 5.56mm

The weapon was made by PT. Pindad Indonesia used by TNI personnel has an empty weight of 4.02 kg and full weight of 4.38 kg. With NATO standard 5.56 x 45 mm munitions and a barrel length of 449 mm, the SS-1 V1 can fire very accurately up to a distance of 400 meters. Mobility in using the SS1 can be made easier with the collapsible butt [10].

Figure. 5. Handgun SS1-V1 Cal. 5.56mm [10].

C. Sailing Distance

The patrol area chosen in this study refers to areas where illegal fishing violations often occur, including the nine-dash line case by China in the Indonesian EEZ area. From the violation map above, the patrol area/shipping distance is determined by using Google Earth. sailing distance as far as 489.06 NM from the strait Lampa pier.

Figure. 6. Distribution of Illegal Fishing Vessels in North Natuna Waters [11].

1. Gross Number Calculation

In calculating the Ground Number [12], use the following formula:

$$Fn = \frac{Vs}{\sqrt{g.L}} \quad (1)$$

Where,

Fn = Froud Number
Vs = speed of ship (m/s)
g = Accelerationgravity (9.81 m/s^2)
L = length of the ship at the waterline (m)

Then the value of the ship's Gross Number is obtained:

$$Fn = \frac{12.86}{\sqrt{9.81 \; x \; 50.2}}$$

= 0.579

2. Ship Coefficient Calculation

From the Froud Number value obtained, the next step is to calculate the coefficients on the ship. The ship coefficients in question include Block coefficient (Cb), midship coefficient (Cm), water plan coefficient (Cwp), prismatic coefficient (Cp), volume displacement (∇), and displacement (Δ) [13]. The calculation of the coefficients is as follows:

a) Block coefficient (Cb)
CB = -4.22 + 27.8√Fn – 39.1 Fn + 46.6 Fn^3 (2)
= 0.391

b) midship coefficient (Cm)
Cm = 1.006 – 0.0056 Cb$^{-3.56}$ (3)
= 0.729

c) water plan coefficient (Cwp)
Cwp= Cb / (0.471 + 0.551 Cb) (4)
= 0.805

d) prismatic coefficient (Cp) (5)
Cp = Cb/Cm
= 0.536

e) displacement volume (∇) (6)
∇= L x B x H x Cb
= 564.73 m^3

f) displacement (Δ) (7)
=564.73 x 1.025
= 578.8ton

3. Making Lines Plan

Lines plan is a depiction of the shape of the pieces of the ship's hull transversely or longitudinally which is then projected in 2-dimensional form. The projection of the 3-dimensional shape of the ship will be displayed in a single image in the form of lines and points. This line plan or Lines Plan is the first step in designing a ship which will later be needed in the work of subsequent designs [14].

In a ship, there are 3 forms of intersection, namely the Body Plan, Half-Breadth Plan, and Sheer Plan. From this intersection, there are 3 lines with details of 2 straight lines vertically and horizontally and 1 curved line. These lines will be interconnected with each other by looking at the projections of each of these lines [14].

The ship line plan is made using the Maxsurf modeler advanced V8i software so that the desired size and shape of the ship's hull are obtained and has a coefficient that meets the recommended criteria in calculating ship resistance with the Holtrop method which will be discussed at a later stage. This lines plan design will produce three projected images, namely, a body plan, a sheer plan, and a half breadth plan.

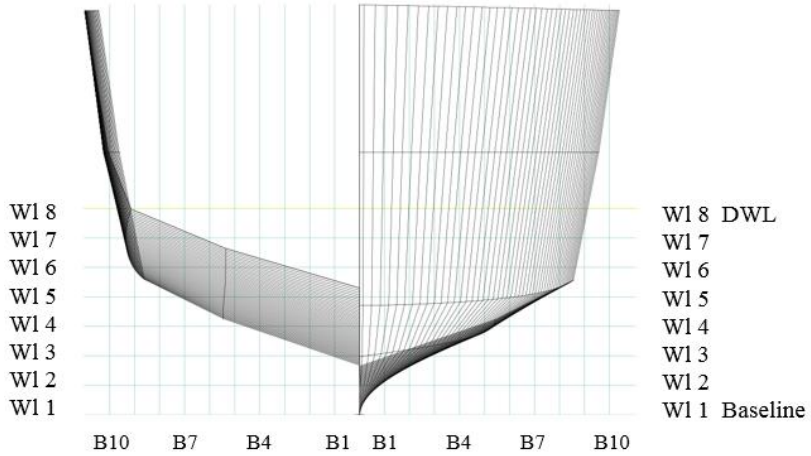

Figure. 7. Ship's Body Plan.

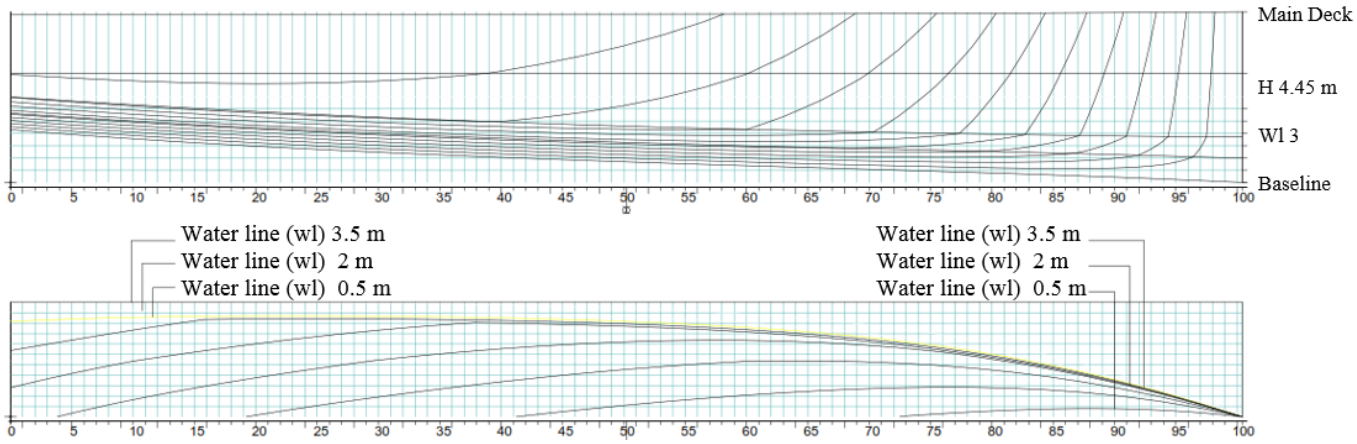

Figure. 8. Bread and Sheer plan.

4. Total Resistance

Ship resistance can be defined as the velocity of the fluid force flow rate that hinders the direction of the ship's movement which consists of waves hitting the hull below the surface of the water and wind blowing the top of the hull [15][16]. To reduce the amount of resistance, many researchers innovate on the ship's hull, one of which is by adding a fin stabilizer to the hull [17].

The calculation of the total ship resistance is carried out with the aim of getting the engine power needed by the ship. Many other studies have shown that ships can sail at the speed desired by the owner (owner requirement). To calculate the ship's resistance, the Holtrop method is used. The author uses the Holtrop method because the Fn value of the designed vessel falls into the Displacement Phase range, namely Fn = 0.579 (0.0 < Fn < 0.6)

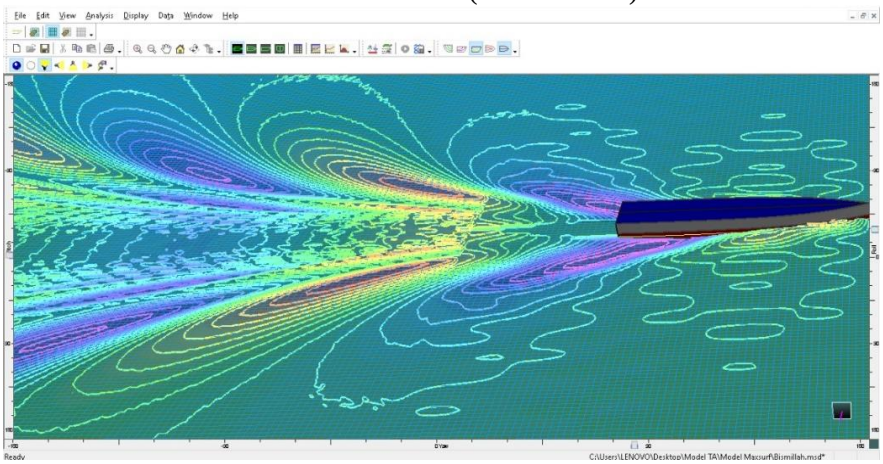

Figure. 9. Results of Running Barriers on maxsurf

The analysis is assisted using Maxsurf Resistance software. The resistance calculation method used is the Holtrop method with the value of the ship's resistance at a speed of 25 knots of 245.9 kN, and the required engine power is 3162,959 kW plus a margin of 15% so that the engine power is 3637,403 kW. Because the ship to be designed uses 2 engines, the power is divided into 2 with a final result of 1818,701 kw, on this basis the ship engine with the MTU brand is selected with a power of 1840 kW.

TABLE 1.
MAIN ENGINE SPECIFICATIONS

The selected engine specification data are:		
Brand	MTU	
ICFN power rating	1840	kw
Engine Model	16V 4000 M23S	
Rate Speed	1800	rpm
Bore/Stroke	170/210	mm
Total displacement	76.3	l

Source: Rolls-Royce, MTU 2022 [18]

5. General Arrangement

The general plan can be defined as a planning drawing and division of space for all ship needs and equipment according to the location and access required. The general plan is made based on the line plan that has been made previously. With a line plan, the outline of the shape of the hull will be visible making it easier to plan and determine the division of space according to their respective functions. The General Plan contains planning for laying cargo, laying equipment and equipment, dividing bulkheads, and so on. The drawing of this General Plan is done using the help of AutoCAD software.

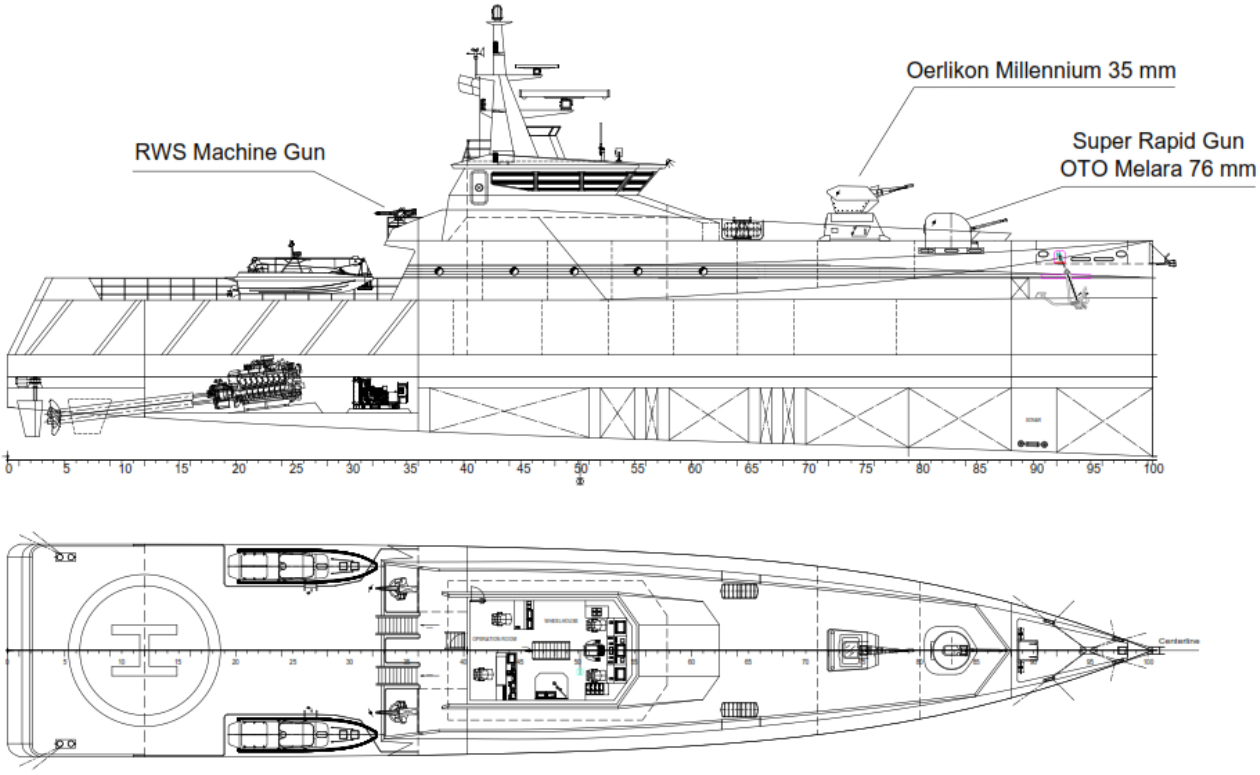

Figure. 10. General Arrangement of Patrol Ship Design.

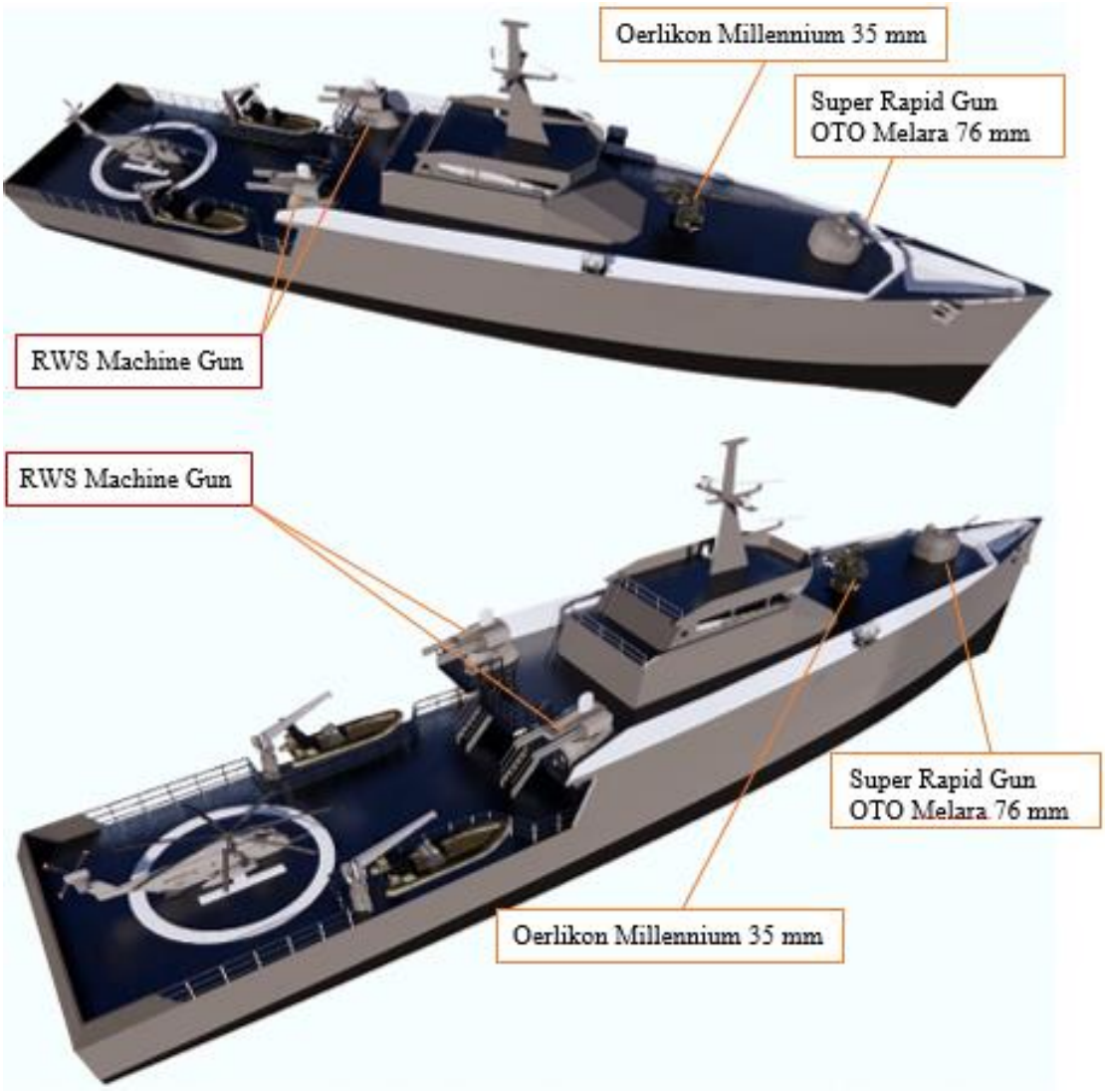

Figure. 11. Isometric View of Patrol Ship Design

IV. CONCLUSION

Based on the technical analysis and calculations that have been carried out regarding the design of the patrol ship type warship as security support in the Natuna waters, it can be concluded that the main ship sizes planned are LOA : 50.2 meters, B: 9.32 meters, H: 4.45 meters, T: 3.5 meters, Vs: 25 knots, and Crew: 40 Indonesian Navy. As for the weaponry used in this study, the Oto-Melara 76/62SR 76mm, Oerlikon Millennium 35mm, RWS Machine Gun, and SS1-V1 handgun with caliber 5.56 mm.

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