THE 1ST LEWIS
The 1st Lawang Sewu International Symposium
Volume 1, November 2022
E-ISSN : 2987 - 2685
page 92 - 102

Design of Hybrid Propulsion Fishing Boat

Hanityo Adi Nugroho[1], Samsudi Raharjo[1*], Rubijanto Juni Pribadi[1]
[1] Faculty of Engineering, Universitas Muhammadiyah Semarang, Indonesia
*Corresponding author : samraharjo2@gmail.com

ABSTRACT

Serui, the capital of the Yapen Islands Regency, is a city in Papua. Maridei Beach is a tourist location located in the Yapen Islands, Serui, Papua. Details of the location of this beach are located in Chief Village, Anotaurei District, Serui, Yapen Islands Regency, Papua. The waters of Serui, Papua province, are one of the areas that have the largest marine and fishing potential in Indonesia, especially for aquaculture as well as freshwater and marine fisheries. The coastal area of Serui has the potential to catch quite a large amount of fish in the sea area with highly economic value. The ship's design research conducted to enforce sustainability issues of capture fisheries technology with automatic features, and sensors are controlled by the autonomous module. The hybrid-driven engine, where the propulsion is driven by a battery-powered propeller system and a diesel engine with a capacity of 2,500 cc, which serves to charge the battery. The ship's skeleton is made of steel, and the walls of the ship are made of fiber with bamboo fiber reinforcement.

Keywords: Serui Papua, Fishing Vessel Design, Automatic Features and Sensors, Hybrid Driven Engines

1. INTRODUCTION

According to the consortium of five Muhammadiyah Universities, i.e., Universitas Muhammadiyah Semarang, Kalimantan Timur, Kalimantan Tengah, Surabaya, and Purwokerto, which discussed research projects in accordance to the division of clusters by the Ministry of Research, Technology, and Higher Education, stated that the fishing sector has social and economic importance for the people of Indonesia. It is estimated that as many as 3,326,900 people in Indonesia work as fishermen, with details of 2,573,300 people as fishermen at sea and 753,600 people in public waters [1].

In Indonesia, fishing vessels must follow the rules of Biro Klasifikasi Indonesia (BKI) or the Indonesian Classification Bureau in the design and construction process, as well as the Regulation of the Menteri Kelautan dan Perikanan Republik Indonesia, or Minister of Maritime Affairs and Fisheries of the Republic of Indonesia, and Keputusan Menteri, or the Ministerial Decree, in using fishing aids used on ships, also in terms of the main size, especially gross tonnage (GT) and fishing aids, as well as their processing on board. GT relates to the capacity and loading capacity of ships in the fishing business. There are several rules and policies regarding fishing gear and fish processing equipment that will be used on ships according to the GT size of the fishing vessel [2].

With the availability of great potential, the marine and fisheries sectors can become an "odyssey to prosperity", or a path for Indonesian people to prosperity. This is possible

E-ISSN : 2987 - 2685
page 92 - 102

because the fishing sector is one of the main sectors that will lead Indonesia as an economically developed country by 2030. To make this happen, sustainable and sustainable management of fish resources is needed [3].

The fishing sector is one of the potential sectors to contribute to Indonesia's state income, which has often been neglected due to development and all state activities focusing on the land sector. This is also marked by the number of fishing vessels in Indonesia only reaching 4,470 units based on data on fishing vessels registered on the official website of the Kementerian Kelautan dan Perikanan (KKP) or Ministry of Maritime Affairs and Fisheries, which when compared to other fish producing countries such as China, which has reached more than 200,000 units, fishing vessels with catches of 61.7 million tons in 2013. Nevertheless, the fishing sector remains one of the largest sources of state revenue, and according to data in 2017, captured fishing production reached 7.7 million tons with a value of Rp. 158 trillion [4].

In order to achieve the objective of managing fishery resources, the Minister of Marine Affairs and Fisheries, through Article 7(1) of Law No. 31 of 2004, in conjunction with Law No. 45 of 2009, is required to determine the potential and allocation of fish resources in the fishery management area of the Republic of Indonesia. As a basis for determining the potential and utilization level, several studies of fish resource stocks have been carried out. The study of fish resource stocks is the main basis for fishery resource management measures. With the existence of continuous stock studies, the newness of the data can be used as a basis in formulating fishing resource management policies accurately and carefully to realize the improvement of fishermen's welfare in Indonesia [5].

The design of boat construction is currently developing, with discoveries in the form of combining two (two) different materials, known as composite materials. A Fiber Reinforced Plastic (FRP) composite material is one of the most commonly used composite materials, consisting of reinforcement and a matrix. The advantages of FRP itself include having dimensional stability, resistance to chemicals, being a good electrical insulator, being suitable for mass production with various production processes, and having a fairly high ratio of stiffness to weight [6].

What has also been in the spotlight recently is the Wilayah Pengelolaan Perikanan Negara Republik Indonesia (WPPNRI), or State Fisheries Management Area of the Republic of Indonesia 711 which includes the waters of the Karimata Strait, Natuna Sea, and South China Sea (Riau Islands). The contributing factors are the weak supervision of the Indonesian state over the territorial sea borders in this region, and also the lack of utilization of marine potential by domestic fishermen, which can be caused by the lack of a fleet of fishing vessels and also the lack of technology used on fishing vessels, so that it limits the capabilities of fishing boats [7].

In fact, based on the existing data, the potential for marine fish resources in the South China Sea (WPP 711) is estimated at 1,057,050 tons/year and it is estimated that the Riau Islands marine area has a fish resource potential of 860,650.11 tons/year including fish on the reefs (503,025.30 tons/year), demersal fish of 272,594.16 tons/year, reef fish of 17,562.29 tons/year, and other species of fish (squid, shrimp, and lobster) (10,666.02 tons/year). Therefore, in this study, a hybrid fishing vessel made of HDPE plastic will be

E-ISSN : 2987 - 2685
page 92 - 102

designed to support the utilization of the marine potential of the Riau Islands Province that utilizes renewable energy in the form of wind, sun, and hydrogen gas.

Maridei Beach, Serui is also a tourist destination located in Chairmanpi Village, Anotaurei District, Seruni, Yapen Islands Regency, Papua. The coastal area of Serui has a large enough potential to catch fish in the sea area [7].

In this study, research on the design of a fishing boat with hybrid (diesel and electric) power was carried out. The skeleton of the ship is made of steel and the walls of the ship are made of fiber with bamboo fiber reinforcement. Research in the field of fishing vessels and their fabrication with electric propulsion hybrid power specifications with a capacity of 2 (two) people and used as fishing vessels for fishermen.

2. LITERATURE REVIEW

2.1. Fishing Boat

A fishing vessel is a vessel specially constructed and used to catch fish in accordance with the fishing gear and fishing techniques used, including to accommodate, store and preserve. Based on data from the FAO's official website, in 2004, there were 4 million commercial fishing vessels of which 1.3 million were vessels with closed decks and 40 thousand of them weighed more than 100 tons. About 2/3 of the 4 million boats are traditional fishing boats that are still driven by sails and oars. Fishing vessels are distinguished based on the type of fishing gear and also the method of fishing carried out, including the following [8].

1) Seiners

Seiners type fishing boats or often also called purse seines refer to fishing vessels that use fishing gear in the form of trawl/seine, this type of ship is usually used to catch fish near sea level.

2) Longliners

Longliners type fishing boats are a type of troller/trawler fishing boat, however, when catching fish, they use many fishing lines, while Longliners only use one very long fishing line equipped with approximately 1000 baits.

3) Gillnetters

Gillnetters fishing vessels refer to vessels that use gillnet fishing gear/gill nets to trap fish that will be caught in the net at the gills. This type of fishing gear can be operated either manually or assisted by automatic technology for better fish catches

4) Crabbers

Crabbers are fishing vessels whose main purpose is to catch crustacean marine catch species such as lobster and crab. This type of fishing vessel is equipped with special fishing gear in the form of traps placed on the seabed to trap crustacean marine life.

5) Trawlers

Trawlers are a type of fishing boat that is very common in the world of fisheries. As the name suggests, the fishing gear on this ship is in the form of a trawl net that is used to catch large numbers of fish on the surface in one operation of this fishing gear. In this type of ship, the fishing process takes place with a trawl thrown into the

E-ISSN : 2987 - 2685
page 92 - 102

sea and then pulled by a ship moving forward. There are three configurations of fishing gear, namely side trawlers, beam trawlers and stern trawlers [9].

6) Drifters

Drifters refer to a type of fishing vessel that uses fishing gear in the form of tow nets to transport and trap fish. A net thrown into the sea will fall like a curtain and this type of fishing gear is commonly used to catch small pelagic fish, namely herring [10].

7) Factory Ship

Factory ship is a type of fishing vessel that functions like a fish factory on land to catch and also process the catch into semi-finished products or finished products such as canned fish. Some types of factory ships do not catch fish directly, but only collect catches from several fishing vessels and then carry out on-board processing to then be brought ashore in the form of finished products.

2.2. Fishing Equipment

Based on the Regulation of Menteri Kelautan dan Perikanan (PERMEN-KP) Republik Indonesia or the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia art. 71 of 2016 in Chapter III Article 6 there are 10 groups of fishing gear (Alat Penangkap Ikan, API) used in WPPNRI (Fisheries Management Region of the Republic of Indonesia, i.e.:

1) Surrounding nets

This type of API is commonly used on purseiners. Ring nets are also known as purse seines, which are operated by wrapping a ring-like net to trap fish.

2) Seine nets

This type of API is operated by spreading it to the area of a school of fish and then the trawl is pulled towards a ship that is stopped or anchored or towards land/beach. This type of API operation can be carried out on surface, mid and bottom waters. Drag trawls are divided into two, namely beach trawling and boat trawling (dogol/danish seines, scottish seines, pair seines, payang, cantrang and also basic throwing) [11].

3) Trawls

This type of API has been banned from being operated in several fishing areas throughout Indonesia, especially for trawlers which are operated on the bottom of the waters, but in reality there are still fishing vessels that use trawls. At first glance, the shape of this API is the same as the type of drag trawler, but what makes the difference is that during operation, the trawler will be spread to areas where there are a lot of fish, then the trawler will be pulled by a boat traveling at a certain speed. Trawls consist of bottom trawls, midwater trawls, otter twin trawls and push trawls [12].

4) Dredges

This type of API is operated in a way such as scratching the bottom of the water with the target of reef fish and coral biota. The dredges commonly used consist of boat dredges and hand dredges which are manually operated by fishermen from the coast.

E-ISSN : 2987 - 2685
page 92 - 102

5) Lift nets

This type of API consists of anco (portable lift nets), boat lift nets (bouke ami and boating chart) and also lift nets. The lifting net is operated with the help of outriggers on both sides of the ship as a support for the net which will be lowered to the surface of the water. The stability of the ship is important because the additional movement of fish entangled on both sides of the ship can destabilize the ship [13].

6) Dropped gears

This type of API consists of cast nets as well as stocking nets. The operation of this API is to spread the nets into the water, after a while, the rope locking the bottom of the net is pulled and the net will close to trap the fish and then pulled to the boat deck.

7) Gillnets and entangling nets

This type of API consists of fixed, drift, circular, staked, layered gillnets and also combined gillnets-trammel nets. Basically, API type gill nets are passive/immovable fishing gear so they don't need more power during the fishing/entrapment process.

8) Traps

This type of API consists of stationary uncovered pound nets/set nets, pots, fyke nets, stow nets (togo, pukat anchor, ambai, jermal, pengerih), muro ami, seser and others. API traps are used to specifically catch fish and crustaceans at the bottom of the water.

9) Fishing rods (hooks and lines)

This type of API consists of handline and pole-lines/hand operated (handlines, fishing rods, huhate and squid angling), handline and pole-lines/mechanized (squid jigging and mechanical huhate), basic rawai, drifting rawai (tuna and longlines, tonda (trolling lines) and kite fishing. The operation of this type of API is to use a hook that is hung on a long rope to lure fish in groups to the surface of the water.

10) Grappling and wounding tools

This type of API consists of spears, shields and arrows. The operation of this type of API is done manually, namely the fishermen will dive into the school of fish slowly and then at the right time will release a spear or arrow to injure and catch fish.

2.3. High Density Polyethylene (HDPE)

High Density Polyethylene (HDPE) is a type of thermoplastic that has high stiffness with a density value of 946-972 kg/m3 . HDPE has several advantages as a basic material for ship hulls, namely having good resistance to corrosion, biofouling growth, aggressive chemical fluids and UV light.

2.4. HDPE ship

HDPE ship is a ship made of thermoplastic material. The production of high-density polyethylene vessels has two main methods, namely the rotating molding method and the welding method. The rotating molding method was the first method used to manufacture polyethylene vessels. The use of molds made of steel plates which will later be heated and rotated, intended so that the melted plastic ore can stick to the surface of the mold. The

E-ISSN : 2987 - 2685
page 92 - 102

second method is the method by welding. There are three main types of HDPE welding, Butt Welding, Tack Welding and Extrusion Welding.

2.5. Hybrid System

Along with rapid development of technology, environmentally friendly and zero emissions are being developed, such as the shift from the use of diesel engines to the use of electric engines. The Energy Observer is a ship that was converted from a racing boat into the world's first research vessel that uses hydrogen gas produced directly on board. The main mission of this research vessel is to travel the world to prove that with energy derived from environmentally friendly renewable energy it can be used on a 6-year expedition, visiting 50 countries, with 101 stops starting from 2017 to 2022. Electrical energy is the main power in Energy Observer ships are obtained from three renewable energy sources namely sunlight, wind, and Hydrogen [14].

2.6. Hydrogen Production Process

The process of producing hydrogen gas from seawater is divided into three, namely:

1) Desalination Process

The working principle of a desalinator is basically to purify seawater into fresh water (H2O) by setting aside other mixtures in seawater such as mineral content, salt, and other residual substances.

2) Electrolysis Process

The electrolysis reaction process requires a certain amount of electrical energy to release the ions that bind to a compound. Electricity that is applied to the electrolysis cell will produce ions that are formed at the positive electrode (anode) and also the negative electrode (cathode).

3) Compression Process

Due to the standard state/room temperature (STP) the nature of hydrogen gas has a very low density, which is only H2 = 0.08988 kg/m3, then in general the storage of hydrogen gas in gaseous form is in the pressure range of 150-350 bar or more.

2.7. Fuel Cell

A fuel cell is an electrochemical cell that can convert chemical energy from fuel into electrical energy by means of an electrochemical reaction with the main fuel hydrogen gas and oxygen/other oxide gases. The chemical reactions in the fuel cell are:

$2H2 + O2 \rightarrow 2H2O$, and fuel cells are also divided into several types, namely:

a. Alkaline Fuel Cell (AFC)
b. Proton Exchange Membrane Fuel Cell (PEMFC)
c. Direct Methanol Fuel Cell (DMFC)
d. Phosphoric Acid Fuel Cell (PAFC)
e. Molten Carbonate Fuel Cell (MCFC)

E-ISSN : 2987 - 2685
page 92 - 102

2.8. Photovoltaic Panel

Photovoltaic (PV) panels are a technology that can collect energy by converting solar energy into electrical energy that can be used in everyday life through a process called the photovoltaic effect. According to the function and materials used in the manufacture of solar cells, there are several types of solar cells on the market. among others :

a. Monocrystalline
b. Polycrystalline
c. Thin Film Solar Cell (TFSC)

2.9. Vertical Axis Wind Turbine (VAWT)

Vertical Axis Wind Turbine (VAWT) is a type of wind turbine that has a vertical rotor/blade design or the shape of an egg beater and in many ways has similarities to the wind-powered centrifugal ventilators seen on the roof/chimney of a factory [11].

3. METHODS

3.1. Research Methods

3.1.1. Purposive Sampling Area

The Fisheries Potential of the Papua Islands, Serui

Fisheries and marine potential in the Papua Island region are very abundant because this region has very wide territorial waters and, at the same time, it also has various types of marine biota with high economic value. Therefore, the fishery and marine sector are one of the leading sectors in West Papua Province as a source of regional original income. The fishing and marine sectors in West Papua Province have a huge opportunity to be continuously stimulated and developed. Most of the fishery production in this region is in the form of capture fisheries, marine aquaculture, ponds, karamba, floating nets, and rice fields (mina padi), and marine aquaculture is the largest contributor to the fisheries sector of West Papua Province [1].

Figure 1 *Papua Island, Seruai*

E-ISSN : 2987 - 2685
page 92 - 102

Serui, as the capital of the Yapen Islands Regency, is one of the cities in Papua. Maridei Beach is a tourist location in the Yapen Islands, Serui, Papua. Details of the location of this beach are located in Chairmanpi Village, Anotaurei District, Seruni, Yapen Islands Regency, Papua. The waters of Serui, Papua province, are one of the areas that have the largest marine and fishing potential in Indonesia, especially for aquaculture as well as freshwater and marine fisheries. The coastal area of Serui has the potential to catch quite large fish in the sea area.

3.1.2. Experimental Design

In general, the stages of this research consist of several steps. The first step is to conduct a literature study on the classification of fishing vessels and the fishing gear used. The next step is the collection of supporting data from research, such as the main size of similar vessels and regulations on the construction of fishing vessels. The last step is to design fishing vessels; analysis of obstacles; drawing of line plans and general plans.

The stages of implementation are as follows:

a. Create a design using CAD (3D modeling);
b. Making prototypes with 3D printing technology;
c. Planning the propulsion system for the ship;
d. Building a working ship.

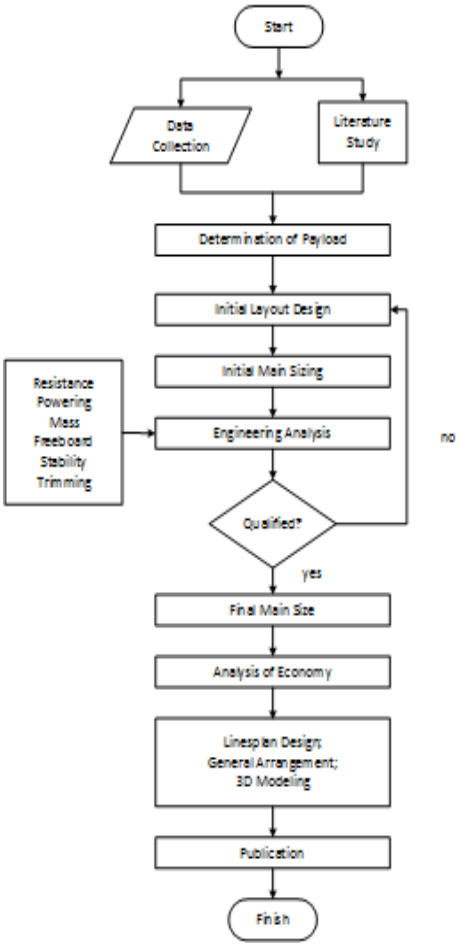

Figure 2 *Ship Design Process Flowchart*

E-ISSN : 2987 - 2685
page 92 - 102

4. RESULTS AND DISCUSSION

The geometry and visual design of the ship (Figure 3), while the specifications and features to be embedded in the ship are shown in Table 1. All automatic features and sensors are controlled by the autonomous module. hybrid-driven engine, where the propulsion is driven by a battery-powered propeller system. The diesel engine used has a capacity of 2,500 cc, which serves to charge the battery.

The simulation were acquire by employing the yield strength calculation and the Von Misses failure criteria as shown in equation below:

$$U_d = \frac{1}{6G}\left(\sigma_a^2 - \sigma_a\sigma_b + \sigma_b^2\right) \quad (1)$$

The failure criteria also known as the Von Misses Failure Criterion.

Figure 3 *Visual Design of the Ship*

Table 1. Specifications and features of electric boats:

Spesification	Unit	Value
Dimension (outer dimension)		
Length	(m)	7
Width	(m)	2,6
Height	(m)	3,5
Power System		
Battery (3 units battery)	Volt	80
Propulsion System		
Motor (Voltage)	Volt	72
Power	kW	75
Current	A	75
Maxpower	kW	22,5
Speed	rpm	6,500
Speed (working load)	rpm	100
Torsi	N.m	3,000
Diesel Engine	cc	2,500
Features:		
- Hybrid engine		
- Anti collision		
- GPS navigation		
- Anti a ground		

E-ISSN : 2987 - 2685
page 92 - 102

Spesification	Unit	Value
- Sensors: ultrasonic and gyroscope, GPS module Anti roll, yaw, pitch		
- Light weight composite materials		

The design and simulation of the ship hull, and fishing net strut of the ship after being simulated, shown in Figure 4. a.b, and c.

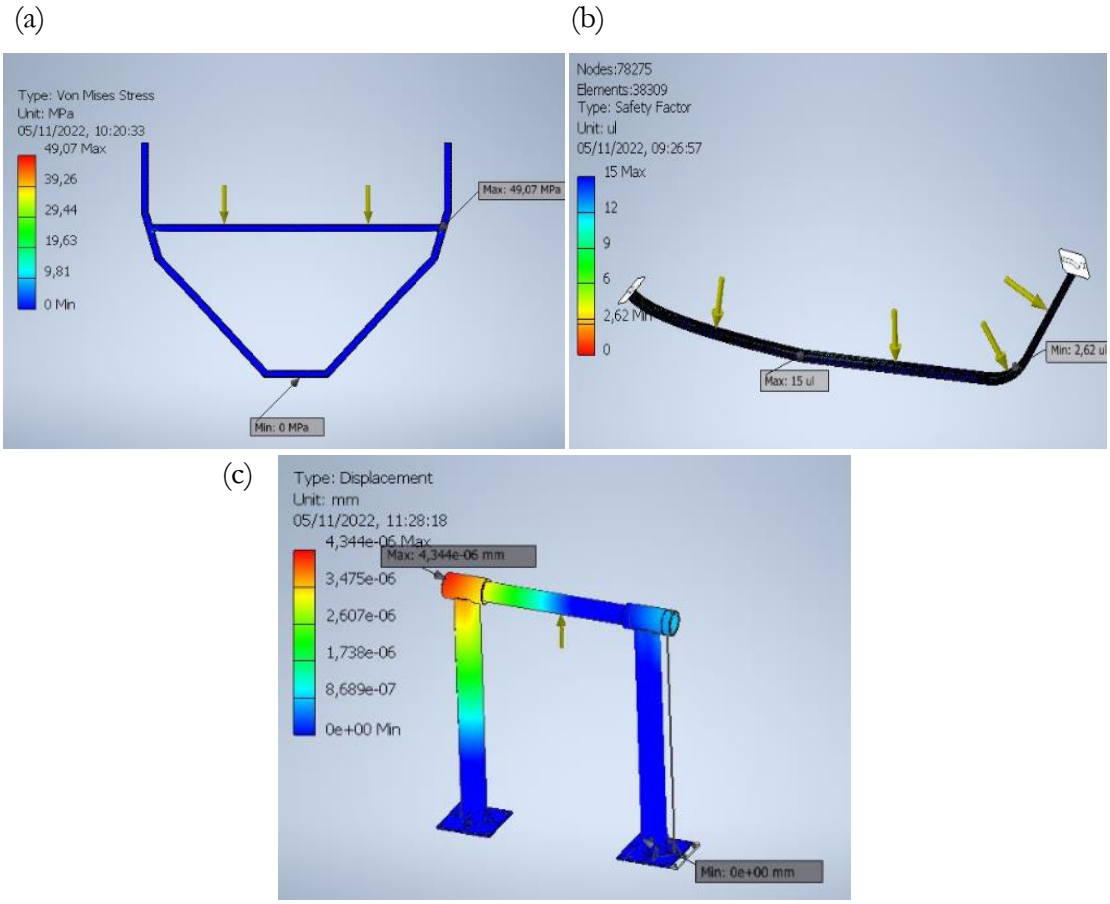

Figure 4 *Design and simulation of the ship hull*

5. CONCLUSION

Based on the results of research and discussion, the following conclusions can be drawn : The capture fishing sector has social and economic importance for residents in the Seruai Papua region, whereas design fishing vessel has automatic features and sensors are controlled by the autonomous module. hybrid-driven engine, where the propulsion is driven by a battery-powered propeller system. The diesel engine used has a capacity of 2,500 cc, which serves to charge the battery.

REFERENCES

[1] BAPPEDA Kepulauan Papua, "Sektor Perikanan," 2022.

E-ISSN : 2987 - 2685
page 92 - 102

[2] W. A. Niam and H. Hasanudin, "Desain Kapal Ikan di Perairan Laut Selatan Malang," J. Tek., vol. 6, no. 2, 2017.

[3] Sharda, "Types of Fishing Vessels," Marine In Sight, 2017. [Online]. Available: www.marineinsight.com.

[4] S. B and W. D. Aryawan, "High Density Polyethylene (HDPE) Vessel of Pompong as a Fishing Vessel for Bengkalis Fisherman," in The 2nd International Seminar on Science and Technology, 2017, pp. 108–114.

[5] A. Hidayat, "Desain Kapal Penumpang Hybrid Berbahan Dasar HDPE Untuk Rute Sumenep-Gili Labak, Kabupaten Sumenep-Madura," ITS, 2016.

[6] V. Erussard, "The Mission," Enery Observer, 2018. [Online]. Available: http://www.energy-observer.org.

[7] T. Tronstad, H. H. Astrand, G. P. Haugom, and L. Langfeldt, Study on The Use of Fuel Cells in Shipping. Hamburg: DNV GL - Maritime, 2017.

[8] M. F. I. Afrianta and H. Anita Kurniawati, "Desain Kapal Pengolah Ikan sebagai Bahan Baku Pembuatan Tepung di Perairan Lamongan," J. Tek., vol. 6, no. 2, 2017.

[9] D. Stolten and T. Grube, 18th World Hydrogen Energy Conference 2010 - WHEC 2010: : proceedings, vol. Bd. 78,3. Forschungszentrum Jülich GmbH, 2010.

[10] P. M. Fernandez, W. D. Aryawan, and G. M. Ahadyanti, "Desain Fast Displacement Ship untuk Lomba Kapal Cepat pada HYDROCONTEST," J. Tek., vol. 7, no. 2, 2018.