Utilization of Solar Energy on 10 GT Fishing Vessels as Alternative Electricity Facilities at PPI Cituis Tangerang Regency

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Abstract. The purpose of this study is to design or design a 10 GT fishing vessel for the territorial waters of Pakuhaji District, Tangerang Regency. This research is expected to provide benefits in getting the shape and size of fishing vessels that are suitable for the territorial waters, providing input to the Tangerang Regency Government, especially the Fisheries Service in the context of increasing the empowerment of fishing communities. The designed ship is planned to use materials / raw materials made of aluminum, fiberglass or wood. Material / raw material for the ship is still easy to find in the Greater Jakarta area. The design of the fishing vessel includes determining the basic size, making line drawings, preparing general plans, construction designs, stability diagrams, engine power, electricity, tonnage and stability. The results of the maximum electricity demand is 495 Watt, 2 solar panels, and 3 batteries / batteries.

Keywords: Fishing vessels, Solar energy, Welfare, environmentally friendly

1 Introduction

The potential of Indonesia's marine fisheries resources is 6.6 million tons / year, but only a portion of which can be captured by Indonesian fishermen is $\pm$ 4.7 million tons / year, partly stolen by fishermen of neighboring countries. This is due to the limited number and large size of fishing vessels in operation. According to the Head of the Maritime and Fishery Human Resources Development Agency, the Indonesian Ministry of Maritime Affairs and Fisheries estimates that the potential number of fish resources allowed in the Indonesian fisheries management area reaches 12.5 million tons [6].

One area that has potential for capture fisheries is Pakuhaji District, Tangerang Regency, Banten Province. Pakuhaji Subdistrict has a coastal area which is directly facing the Java Sea. This region has a coastline of $\pm$ 6 (six) kilometers. This region has a Cituis Fish Landing Base (PPI), precisely located in Surya Bahari Village.

Surya Bahari Village Area, Pakuhaji District, Tangerang Regency has great potential for capture fisheries. In this region, there is a Fish Landing Base (PPI) which is capable of anchoring fishing vessels up to a maximum size of 10 Gross Tonnage (GT) vessels. The fishing boat with a size of 10 GT is intended for inland waters and archipelago waters. In order to improve the capabilities of the fishermen in the Pakuhaji

District, fishing vessels need to be built that are suitable for this region and are energy efficient. If the design / construction and construction of fishing vessels can be realized, then in turn the welfare of the fishermen in this region will increase [1].

Fig.1. Map of PPI Cituis

The designed ship is planned to use materials that are generally used to build ships with a relatively small size [8]. The design of the ship includes determining the basic size, making line drawings, preparing general plans, construction designs, stability diagrams, engine power, solar energy, and tonnage.

To meet the criteria of energy saving and environmentally friendly, the electricity generating equipment for lighting at night and other purposes, the designed ship is planned to use solar energy [4].

The length of the PPI Cituis jetty is approximately 150 meters, with a pool depth of less than 70 cm. Can accommodate $\pm$ 10 fishing vessels be measuring an average of 10 GT. Capture land area for catching fish is

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not more than 5 hectares. From the limitations of the available landing facilities, a fishing boat can be designed for a maximum of 10 GT. The problem of electrical energy for lighting purposes during nighttime operations and other electricity needs is a separate problem, which has so far been using a generator constrained by the limited supply of expensive fuel oil. The use of stum storage batteries is identified to be easily damaged due to frequent loading and unloading at the time of filling the stum. To overcome the problems of electrical energy with the alternative use of solar panel installation as a provider of electrical energy as a substitute for the previous electrical energy system.

To design a fishing vessel that will be operated, especially in the waters of Tangerang Regency, there are certainly some things that become the basis of reference. One such reference is the criteria / port class [7].

Table 1. Characteristics of PPI

No	Fisheries Port Criteria	PPI
1	Operational areas of fishing vessels served	inland and Archipelago Sea
2	Ship / berthing facilities	3-10 GT
3	Pier length and depth of pond	50-100 m dan > 2 m
4	Capacity to accommodate ships	> 60 GT (equivalent to 20 vessels 3 GT)
5	Volume of landed fish	-
6	Fish exports	Non
7	Land area	2-5 Ha
8	Facilities for developing fishery products quality	Non
9	Spatial (zoning) processing / development of the fishing industry	Non

The purpose of this study is to design or design a 10 GT fishing vessel for the territorial waters of Pakuhaji District, Tangerang Regency. This research is expected to provide benefits in getting the shape and size of fishing vessels that are suitable for the territorial waters, providing input to the Tangerang Regency Government, especially the Fisheries Service in the context of increasing the empowerment of fishing communities. Fishing Vessel (Fishing Vessel) is a type of fishing vessel specifically used for catching fish, including storing, storing, cooling or preserving [12]. Fishing gear that is only allowed to be used in waters around the ZEEI line is a type of trawl and gill net.

The Fish Landing Base (PPI) is a Type D. fishing port. This fishing port has a land area of 2-5 Ha, and is designed to serve fishing vessels measuring 3 - 10 GT. This fishing port can accommodate 6 ships or 60 GT at a time. This fishing port serves fishing vessels operating in coastal / inland waters and archipelago waters [3].

2 METHODOLOGY

2.1 Reasearch Flowchart

Research methods in the Utilization of Solar Energy on 10 GT Fishing Vessels as Alternative Electricity Facilities at PPI Cituis Tangerang Regency include the research flow and a description of the research flow as shown in Figure 2.

Fig.2. Flowchart of Research Methods

2.2 Research Methods

Table 2. Research Methods Description

Activities	Method	Output
Problem identification and Data Collection	Literature and survey	10 GT fishing vessel survey data as a comparison and PPI Cituis data
Pre-design	Comparison Ratio Methods, The Principal Size ratio : L/B, B/T, D/T	The Principal Size of ship : Loa ; Lpp ; Lwl ; B ; D ; T.
Estimated Vessel Weight	Benchmarks and general formulas	Deadweight and Lightweight
Determination of the General Arrangement	General regulation of ships and CAD software	Figure concept of General Arrangement
Determination of Ship Equipment and Specifications	General regulation of vessels and selection of ship equipment including electrical systems	Ship moving system equipment ; accommodation ; mooring system ; safety ; Equipment operation specifications and procedures.
Determination of Construction	Regulations of the Ship Classification Bureau	Determination of load, number of baffles, frames, hull plates, deck plates.

Tonnage Calculation	IMO Standard	Magnitude of volume of the entire room
Determination of Driving Power	Using Hullspeed analysis	Ship resistance and horsepower of a certain speed, BHP.
Calculation of solar energy and its installation	General calculation	The amount of power generated and the installation circuit
Stability Calculations	Stability Theory and Trim	KG and LCG are empty and full conditions. GZ 0° to sink angle.

3 RESULTS AND DISCUSSION

3.1 Cituis Fish Landing Base (PPI)

The management and guidance of PPI Cituis is under the Tangerang Regency Maritime and Fisheries Office. The role of PPI Cituis is to advance capture fisheries in the area which include aspects of production, processing and marketing. Its operation is greatly influenced by the catch landed. The capacity of the PPI Cituis facility will affect the smooth operation of port activities to fulfill its functions optimally. PPI Cituis is one of the seven PPI in Tangerang Regency that contributes to the Tangerang Regency PAD. The facilities, production and requirements of PPI Cituis are described as in table 3 below.

Table 3. PPI Cituis

No	Facility Infrastructure	Description
1.	Berth length	± 60 meter
2.	Berth pool	High ± 2,5 meter Low ± 1,5 meter
3.	Ship visits	± 30 ships / day
4.	Fishing gear	Sondong (trawl push)
5.	Fish catches	Shrimp, bilis, petek, and tembang
6.	The number of catches	± 120 kg / ship / day
7.	Fuel oil	7500 liters / day
8.	Ice blocks	± 60 block / day

Almost all PPI Cituis facilities are considered to be adequate, except for the capacity to accommodate vessels that need to be added, because sometimes the ship that will lean must wait in line.

3.2 General Arrangement

3.2.1 Main Dimension

A general plan is presented to explain the design of a 10 GT fishing boat with a single engine (1) 54 HP diesel engine and can operate on coastal waters 10 miles from Pakuhaji beach for 10 hours.

Table 4. Main Dimension of Vessel

Description	Size
Length over all (LOA)	14.00 meters
Length of the Water Line (LWL)	12.53 meters
Width, maximum (B max)	3.10 meters
Width, molded (B mld)	3.00 meters
Height, molded (D mld)	1.60 meters
Draft of ship (T)	0.70 meters
Driving machine	54 HP (horse power)
Speed	7-8 knots
Duration of operation	10 hours
Radius distance	80 Nm (nautical mile)

Table 5. Capacity of Vessel

Description	Size
Fish Hatch (Fish + Ice)	4 Tons
Fuel Oil	220 liters
Freshwater	240 liters
Crew / complement	6 people
Gross Register Tonnage (GRT)	10 GT (gross tonnage)

3.2.2 Velocity and Distance Radius

Official speed at 90% Maximum Continuous Rating (MCR) with Sea Margine 15% main engine, with two thirds (2/3) fuel & fresh water capacity, 6 (six) people, on the basis of a clean / slippery hull, 8.00 knots in a state of calm water. At operational time with a full speed of 7.50 knots the condition of the engine is loaded at 90% MCR able to sail a total cruise distance of 80 Nm with 10 hours endurance.

3.2.3 Spatial In Hull

In the hull, 3 (three) transverse waterproof bulkheads are installed dividing the hull of the ship into 4 (four) compartments, with the following arrangement :

1. Stern part

The steering gear holder and 1 (one) Freshwater Tank (FT) unit are placed in the stern niche, as shown in Table 4 below.

Table 7. Freshwater Tank (FT)

No.	Description	Number	Unit
1	Complement	6	People
2	Total engine power	54	Hp
3	Roaming time	0.42	Day
4	Crew	16	l/hari
5	Engine	3.0	Kg/HP
6	Need for engine coolant	195	Kg
7	Drinking water & sanitation needs	40	Kg
	Freshwater tank	235	Kg

2. Engine room

In the engine room placed 1 (one) unit of the Fuel oil Tank (FOT) as in Table 5 below. The room is equipped with adequate natural ventilation to maintain a maximum engine room temperature of 40 ° C.

Table 8. Fuel oil Tank (FOT)

Tanks	Needs		Tanks Volume (m ³)	
	Weight (Kg)	Volume (L)	Remaining	Expansion
Fuel oil tank (FOT)	158	186	204	213
Total	158	186	204	213

3. Fish Hatch

Two fish hatches for storage of fish and ice with the capacity as shown in Table 6 below.

Table 9. Fish Hatch

Storage of Fish (SF)	Volume (m ³)		SWR 76%	Fish 57%	Ice 43%
	Bruto	Grain	Ton	Ton	Ton
Fish Hatch No.1	6.81	5.45	4.14	2.36	1.78
Fish Hatch No.2	4.73	3.78	2.88	1.64	1.24
Total	11.54	9.23	7.02	4.00	3.02

4. Forepeak Room

The maritime equipment warehouse is placed in a bow niche room above the grating.

5. On the deck

The rudder house / bridge room functions as a room to control the ship and as a master bed for 1 (one) person, equipped with steering gear, navigation and communication equipment.

The accommodation room (ABK) functions as a ABK bed with a capacity of 6 (six) people.

3.2.4 Equipment / Inventory

Table 10. Mooring and Anchor

No	Description	Size
1.	Anchor stick	20 kg, iron
2.	Anchor chain diameter	16 mm
3.	Seckel	-
4.	Nylon anchor rope	18 mm x 50 m
5.	Mooring ropes	14 mm x 2 pieces @ 20 m
6.	Throw / throw rope	8 mm @ 20 m
7.	Used tires	-
8.	Bow roller	-

Table 11. Safety Equipment

No	Description	Unit
1	Life jacket	8 pieces
2	Ring buoys	2 pieces
3	First aid kit containing medicines	1 piece
4	Fire Fighting Equipment - Powder type fire extinguisher 2.5 kg	1 piece

Table 12. Navigation Equipment

No	Description	Unit
1.	Mercury Compass 3"	1 piece
2.	National Flag	1 piece
3.	Signaling flags	1 piece
4.	Map of the Indonesian sea	1 set
5.	Ruler row	2 pieces
6.	Term	2 pieces

Table 13. Solar Panel Equipment

No	Description	Unit
1.	Solar panels	2 units above the wheelhouse
2.	Battery	3 units above the engine room

Gear Equipment

- Gill net fishing gear equipment (Gill Net)

Table 14. Description of Gillnet

No	Description	Size / Unit
1	Gill Nett D 6	2.5 inchi
2	Gill Nett D 9	2.5 inchi
3	Gill Nett D 12	2.5 inchi
4	Gill Nett D 15	2.5 inchi
5	Lifebouy Y 8	
6	Lifebouy Y 18	
7	Rope PE "SIGUL" (Blue)	33

Fig. 3. General Arrangement of Fishing Vessel 10 GT

3.3 Construction

This fishing vessel is made with wood raw material. It is intended that the cost of shipbuilding is relatively cheap but the strength of construction is also relatively better, considering that in PPI Cituis the leaning area is

rather narrow so that it often clashes between one ship with another. In the manufacture of wooden ships there are several things that need to be considered, including the composition of good quality materials, both for Lunas (keel), Bottom, Hull, Ivory / framework and other parts. In addition to the composition of the thickness of the material used is also a matter that needs attention [10].

All materials and equipment used for the manufacture of fishing vessels are new, with materials that have good quality test materials and are specifically used at sea.

The material used for the hull structure uses wood material with a minimum thickness of designation as follows : Lunas (keel), Base (Bottom), Hull (Hull), Ivory / Framework (Frame), Deck Floor (Deck), and Upper Building (Deck) Wheelhouse).

3.4 Tonnage

Tonnage is the volume of space on a ship with a Register Tonnage (RT) unit, where 1 RT = 100 ft³ or equivalent to 2.83 m³.

Determination of ship GT according to the method of domestic measurement, is calculated in accordance with the provisions in the Decree of the Director General of Sea Transportation No. PY.67 / 1 / 16-02, using equation (1).

$$GT = 0.25 \times V \text{ (1)}$$

The value of 0.25 is the conversion value from cubic meters to tons of registers.

V = is the total contents of the room below the upper deck plus the rooms above the top deck that are perfectly closed measuring not less than 1 cubic meter.

$$V = (L \times B \times D \times f) + V \text{ of the upper building}$$

$$V \text{ of the upper building is estimated to be } 3 \times 2.5 \times 2.5 = 30 \text{ m}^3$$

$$V = (L \times B \times D \times f) + V \text{ of the upper building}$$

$$= (13 \times 3.1 \times 1.8 \times 0.5) + 17.75$$

$$= 42.23 \text{ m}^3$$

So that :

$$GT = 0.25 \times V = 0.25 \times 42.23 = 10.36 \text{ close to } 10 \text{ GT}$$

$$NT = 0.6 \text{ GT} = 0.6 \times 10 = 6$$

The calculation results of GT vessels 10.36 approaching the GT size of the desired vessel, namely the 10 GT Fishing Boat.

3.5 Main Engine

Table 15. Engine and Propulsion

Description	Size
Marine diesel engine	1 unit
Engine output (BHP)	54 HP
Maximum rotation	1,500 RPM
Fixed propeller	1 unit

3.6 Stability

Calculation of Rolling Period:

$$0.5 \times Cr = 0.373 + 0.023 \times (B/d) - 0.043 (Lwl/100) = 0.4475$$

$$Cr = 0.995$$

$$GM_T = 1.354 \text{ m}$$

$$T = \frac{Cr \times B}{\sqrt{GM_T}} = 8.64 \text{ s}$$

The ship's rolling period 8.64 (s) can be said to have a fairly comfortable stability in the motion of the ship and for the crew.

3.7 Electric Power from Solar Panels

The generated solar cell voltage will be used by the charge controller to charge the battery [11]. To turn on the load of AC devices (alternating current) such as navigation lights, television, radio, communication devices, etc., the battery current is supplied by the inverter [5].

Installation of solar power plants requires planning regarding power requirements, namely the amount of usage, the number of solar panels, the number of batteries [9].

Table 16. The Ship's Electrical Power Needs

No.	Equipment	Power Average (watt)	Quantity	Amount (Watt)
1	Room lighting	20	10	200
2	Spotlights	100	1	100
3	Television	75	1	75
4	Radio	35	1	35
5	Communication tool	75	1	75
6	Others	10	1	10
	Total			495

The number of solar panels / solar cells needed, we count one panel to 100 Watts (calculation is 5 hours maximum solar power), The need for solar panels: 495 / (100 x 5) = 1 solar panel.

The number of batteries needed 12 Volts with 100 Ah each, Minimum battery requirements (batteries are only used 50% to meet electricity needs), thus we multiply the power needs 2 x fold: 495 x 2 = 990-Watt hour = 990/12 Volt / 100 Amp = 2 batteries 100 Ah, Battery requirements (with consideration of serving 2 days without sunlight): 495 x 2 x 2 = 1980 Watt hour = 1980/12 Volt / 100 Amp = 3 batteries 100 Ah.

The number of solar panels / solar cell needed, one panel we count 100 Watt (calculation is 5 hours maximum solar power), The need for solar panels: (1980/100 x 5) = 2 solar panels.

4 CONCLUSION AND SUGGESTION

1. From the results of comparing the basic sizes and equipment, as well as calculating the electrical needs for the ship, the conclusion is obtained as a specification of the 10 GT fishing vessel as below.
2. Fishing vessels designed with the following specifications:

Table 17. Spesification of Vessel

Description	Spesification
Total length (LOA)	14.00 meters
Molded height (D mld)	1.60 meters
Middle ship (T)	0.70 meters
Boat construction	Wood construction
Tonnage: 10 GT	10 GT
Driving machine	54 HP (horse power)
Speed	7-8 knots
Stability	PO 8.4 seconds
Fishing gear	Gill Net
Solar Panel Components	2 solar panels and 3 batteries
Holding space capacity	11.54 m ³
Maximum electricity demand	495 Watt
Solar panels	2 (two) units
Battery	3 units

3. Installing a solar panel system on a fishing vessel will save fuel consumption and increase the technical life of the battery.

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