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Technical and Economic Analysis of Yamaha E15CMHL Outboard Engine Use for 3 GT Fishing Boat Propulsion in Tlocor Village

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Abstract

The Fishermen in Tlocor Village use 3 GT boats equipped with 25 HP Yamaha E25BMHL outboard engines for fishing activities. However, they reported excessive fuel consumption with these engines. This study aims to analyze the technical and economic feasibility of using the 15 HP Yamaha E15CMHL outboard engine as an alternative. Technical analysis included calculating ship resistance using the Holtrop method and comparing it with Maxsurf Resistance software, testing ship speed, and measuring fuel consumption. The results showed a ship resistance value of 1.39 kN (Holtrop method) and 1.4 kN (Maxsurf), with the Yamaha E15CMHL achieving a speed of 7.139 knots and fuel consumption of 8.323 liters/hour, while the Yamaha E25BMHL reached 7.291 knots with 11.023 liters/hour. Economically, the Break Even Point (BEP) for the Yamaha E15CMHL was 44 days, significantly faster than the Yamaha E25BMHL's 128 days. Therefore, the Yamaha E15CMHL is more suitable both technically and economically for 3 GT fishing boats.

Keywords: 3 GT Fishing Boat, Yamaha E15CMHL, Techinical & Economic Analysis

1. Introduction

1.1. Background

Fishing boats serve as essential transportation for fishermen, supporting their daily livelihoods and fishing activities (Dewi et al., 2021). A critical component of these boats is the outboard engine, which powers vessels from departure to return (Harsanto, 1969). In Tlocor Village, Sidoarjo, fishermen utilize 3 GT boats equipped with 25 HP Yamaha E25BMHL outboard engines. However, they report excessive fuel consumption during fishing operations, raising concerns about economic sustainability (Sitepu, 2009). The mismatch between engine power (25 HP) and the vessel's technical requirements may lead to inefficiencies. Studies indicate that overpowered engines increase fuel consumption without significantly improving speed, as thrust must overcome disproportionate hydrodynamic resistance (Sijabat et al., 2018). The Holtrop method and software like Maxsurf Resistance are widely used to analyze ship resistance and optimize engine selection (Holtrop, 1977; Baeda, 2002). Regulatory frameworks, such as Indonesia's Ministry of Maritime Affairs and Fisheries (KKP) guidelines, mandate a minimum speed of 7 knots for fishing vessels, emphasizing the need for balanced engine performance (Amalia, 2021). Additionally, economic viability is critical; the Break Even Point (BEP) analysis helps determine the feasibility of engine investments (Manuho, 2021). This study addresses these issues by evaluating the Yamaha E15CMHL 15 HP engine as a technically and economically efficient alternative for 3 GT boats, leveraging resistance calculations, speed tests, and BEP analysis.

1.2. Research Objectives

From the background description described above, the research objectives include.

1. Obtain the resistance value of a 3 GT fishing boat using the Holtrop method by comparing the resistance value of the Maxsurf Resistance Software.
2. Knowing the technical analysis of 3 GT fishing boats in terms of testing boat speed and fuel consumption between the use of Yamaha E15CMHL outboard engines and Yamaha E25BMHL outboard engines on 3 GT fishing boats.
3. Knowing the BEP (Break Even Point) value between the use of Yamaha E15CMHL and Yamaha E25BMHL outboard engines as an economic feasibility analysis on a 3 GT fishing boat.

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2. Material, methods, and theoretical basis

2.1. Material

2.1.1 Source of Data

The required data sources are technical data on Yamaha E15CMHL outboard engine unit specifications and 3 GT fishing boat data carried out at shipbuilding institute of polytechnic surabaya. The place of data collection and direct observation is carried out during the completion of On the Job Training, namely December 8, 2023 until December 31, 2023.

2.1.2 Research Objectives

Table 1. Main Ship Data

No	Main Ship Data	Description	Units
1.	Vessel type	3 GT Boat	-
2.	L_{PP}	9.22	Meters
3.	L_{WL}	9.587	Meters
4.	$L_{Displacement}$	9.40	Meters
5.	$V_{Displacement}$	2.447	m^3
6.	Width (B)	1.2	Meters
7.	Height of Deck (H)	0.8	Meters
8.	Draft (T)	0.4	Meters
9.	Speed (Vs)	8	Knot
10.	Midship Coefficient (Cm)	0.675	-
11.	Block Coefficient (Cb)	0.576	-
12.	Prismatic Coefficient (Cp)	0.853	-

Table 2. General Specifications of Yamaha E15CMHL Outboard Engine

No	Item Specifications		Units
1.	Model	Yamaha E15CMHL	-
2.	Engine Dimensions	873 x 332 x 1040 (L)	mm
3.	Weight	37.5	kg
4.	Engine Power (max)	15	HP
5.	RPM	5000	r/min
6.	Fuel Consumption	7.3	Ltr/hr
7.	Type	2-Stroke, twin	-
8.	Cylinder Volume	246	Cm^3
9.	Bore x stroke	56 x 50	mm
10.	Lubricating System	Mixed Gasoline	-
11.	Fuel Type	Pertalite	-
12.	Lubricant Oil	Motor Oil Outboard 2 Stroke	-
13.	Transmission Oil	Hypoid Gear Oil	
13.	Compression Pressure	560	kPa
14.	Propeller Round	Clockwise	-

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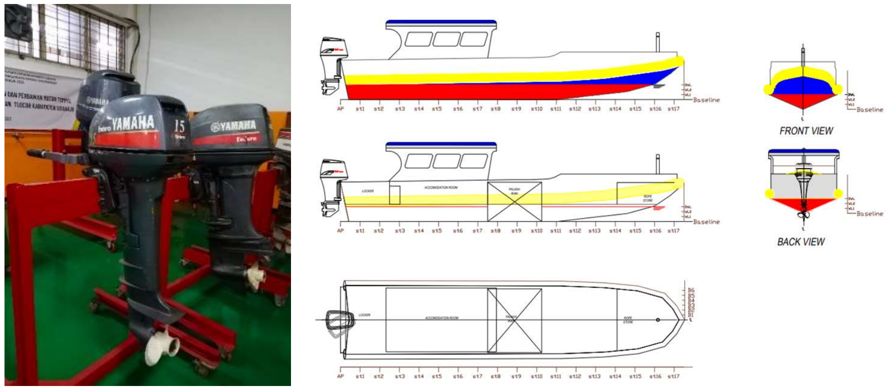

Figure 1. E15CMHL Yamaha Outboard Engine & Design of 3 GT Fishing Boat

2.2. Methods

This study employs a quantitative approach with the following stages:

a) Problem Identification: Analyzing fishermen complaints about the high fuel consumption of the Yamaha E25BMHL 25 HP engine on 3 GT boats.
b) Data Collection:
   - Primary data obtained through field observations and interviews with fishermen.
   - Secondary data includes technical specifications of the 3 GT boat and Yamaha E15CMHL engine.
c) Technical Analysis:
   - Calculating ship resistance using the Holtrop method and verifying with Maxsurf Resistance software.
   - Testing boat speed and fuel consumption under varying loads (25%, 50%, 100%) and RPM (2000–5000).
d) Economic Analysis: Calculating the Break Even Point (BEP) to compare the feasibility of E15CMHL and E25BMHL engines.
e) Validation: Comparing theoretical calculations with software simulations and field test results.

2.3. Theoretical Basis

2.3.1 Outboard Engine

The outboard engine consists of a motor, drive shaft, gearbox, propeller shaft, and propeller. In an outboard engine there are components such as a carburetor, crankshaft, piston, and cylinder. This outboard engine is equipped with a handlebar on the right side of the engine which functions as a steering wheel and gas handle. On the left side of the engine there is a gear lever that functions as a regulator of the forward, backward, or neutral direction of the ship. The outboard engine is directly connected to the rudder so that full control of the engine is at the ship's helm. The system of an outboard engine is similar to a combustion motor system that uses fuel in the form of gasoline. Outboard engines have advantages over other combustion motors in their installation or application on ships, and outboard engines are easier to operate. The outboard engine used as the topic of discussion is the Yamaha E15CMHL 2-stroke outboard engine, this 2-stroke outboard engine requires 2 piston steps or one crankshaft rotation to produce one effort because the effort is used for air intake and exhaust gas discharge, it is done quickly and requires a wide and free road and expansion is carried out early in order to minimize possible losses (Harsanto, 1969).

The working cycle of an outboard engine is as follows, in the suction step (intake), mixing air with fuel is sucked into the crankcase by the piston when the piston moves up through the inlet valve from the bottom left. At the same time, in the upper cylinder chamber there is also high compression of the air and fuel mixture, when the piston reaches its peak height (TMA), a spark from the spark plug burns the fuel, resulting in an explosion and pushing the piston head back down. When the piston returns to the bottom point (TMB), the intake valve will be closed. Transfer or exhaust step, when the piston moves down, the fuel is compressed, after the piston is under the input valve with the state still closed, then the fuel flows into the cylinder and along with the release of combustion residue through the fuel outlet. The next step is compression, the piston rises again because it gets a push from the flywheel force and gets fuel in the cylinder. At the same time, the fuel/gas drawn from the open valve Jura pushes the piston up (Lutfiah, 2022).

2.3.2 Ship Resistance

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Ship resistance is the fluid force acting on the ship's body to work against the ship's motion. The resistance is equal to the fluid force acting parallel to the axis of the ship's motion. This ship resistance is the same as a force and because it is generated by water, it is also called hydrodynamic force. This hydrodynamic force is solely caused by the relative motion of the ship against the water. The magnitude of ship resistance is strongly influenced by the speed of ship motion (Vs), the weight of water moved by the ship's body immersed in water (displacement), and the shape of the ship's body (hull form). Ship speed is strongly influenced by the ship's propulsion system, while displacement and hull form are determined by the main size of the ship (main dimension), the ratio between the main size (ratio), and the hull form coefficient (Sijabat, 2018).
To calculate the resistance of the ship can be used with the holtrop method equation as follows:

$$\mathbf{R_{TOTAL} = R_F(1+k_1) + R_{APP} + R_W + R_B + R_{TR} + R_A + R_{AA}} \quad (1)$$

Notes:

R_F = Frictional resistance based on ITTC-1957 formula
$= 0.5 \times \rho_{Sea\ Water} \times V^2 \times C_F(1+k_1) \times S$

$(1+k_1)$ = Shape factor of the hull
$= 0.93 + 0.487118\ C_{14}\ (\frac{B}{L})^{1.06806} (\frac{T}{L})^{0.46106} (\frac{L}{L_R})^{0.121563} (\frac{L^3}{\nabla})^{0.36486} (1 - C_P)^{-0.604247}$

R_{APP} = Additional resistance
$= \frac{1}{2} \times \rho \times V^2 \times S_{APP}(1+k_2)_{eq} \times C_F$

R_W = Wave resistance
$= C_1 \times C_2 \times C_5 \times \nabla \times \rho \times g \times \exp(m_1\, F_n{}^d + m_2 \cos(\lambda\, F_n{}^{-2})$

R_B = Additional resistance of bulbous bow

R_A = Resistance due to ship model
$= 0.5 \text{ x } \rho \text{ x } V^2 \text{ x } S \text{ x } C_A$
$= \frac{1}{2} \times \rho \times V^2 \times S \times C_A$

R_{AA} = Air resistance

2.3.3 Maxsurf Software

Maxsurf is one of the structural application programs developed by a software development company located in Fremtle Australia, called Formation System (FORMSYS) (Baeda, 2002). Maxsurf Resistance can read and measure Maxsurf design files directly. Since Maxsurf Resistance uses the same method as Hydromax to determine the hydrostatic properties of a design, the same rules and restrictions apply to closed sections (Maxsurf Resistance User Manual Book, 2020).

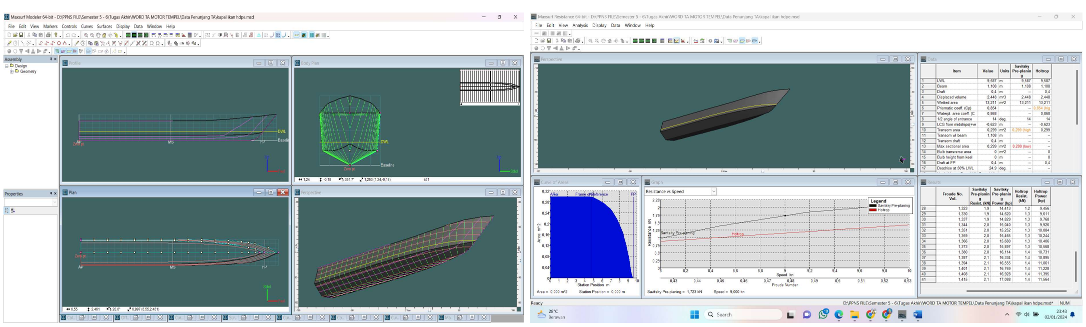

Figure 3. Maxsurf Software Display

2.3.4 Ship Engine Power Requirements

The requirement of the ship at the desired speed is called the engine power requirement. There are two types of engine power, namely continuous power and maximum power. Continuous power to achieve service speed and maximum power to achieve maximum speed or trial speed. In general, propulsion engines on ships are dominated by diesel engines (Diesel Engines) where the advantages of diesel engines are both in terms of their compactness and efficiency. When determining the propulsion engine, generally the aspects of consideration seen in the form of fuel consumption, rotation generated, transmission system, price, and ease of obtaining engine parts. Where the decision to use the engine has future consequences such as high maintenance costs, low acceleration and maneuverability or other technical consequences (Sitepu, 2009).

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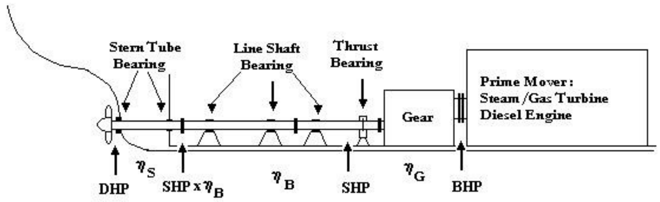

Figure 4. Ship propulsion power distribution

2.3.5 Fuel Consumption

$$\mathbf{Fc} = \left(\frac{SFC \ x \ P}{\rho}\right) \text{(ltr/hr)} \qquad (2)$$

Notes:
Fc = Total fuel consumption (ltr/hr)
SFC = Fuel specific consumption (Kg/kWh)
P = Engine output power (kW)
ρ = Density of gasoline fuel (0.77 kg/ltr)
Fuel consumption in operation can be calculated when using fuel during the voyage, then the economic value of an engine is known.

$$\mathbf{V} = \mathbf{Fc \ x \ T \ (ltr)} \qquad (3)$$

Notes:
V = Total volume of fuel required (ltr)
T = Time of voyage (hr)

2.3.6 Break Even Point (BEP)

The Economic analysis is calculated from the BEP (Break Even Point) value of the use of the Yamaha E15CMHL outboard engine object on a 3 GT fishing boat unit. BEP is a situation where the total revenue is equal to the total cost, which is the break-even point where the fishermen do not get a loss or profit. According to (Manuho, 2021) BEP can be interpreted as a point or situation where the company in its operations does not make a profit and does not suffer losses. The purpose of the BEP analysis is to find out at what sales or production volume a company will achieve a certain profit. BEP analysis can generally provide information to leaders, what is the pattern of the relationship between sales volume, costs, and the level of profit that will be obtained at a certain level of sales. To be able to get the BEP value can be formulated as follows:

$$\mathbf{BEP} = \frac{\textit{Total Fixed Cost Expenses}}{(\textit{Total Revenue} - \textit{Variable Costs})} \qquad (4)$$

Notes:
BEP = Break Even Point / Break-even point value
Fixed cost expenses = Yamaha E15CMHL outboard engine cost
Revenue cost = Fisherman's income (1 day)
Variable cost = Operational cost

3. Results and discussion

3.1. Calculation of Ship Resistance & Engine Power Required Through Maxsurf Resistance Program

After the calculation of ship resistance using the Holtrop method, the next step is the calculation of ship resistance with the help of the Maxsurf Resistance program to utilize modern shipping technology and as a method of approach and proof of the correctness of the ship resistance calculation formula. From the main ship data obtained such as ship length, ship width, water level, and ship height, it can be done resistance analysis with the help of the Maxsurf Resistance program.

When comparing the results of the theoretical calculation of resistance using the Holtrop method and the Maxsurf Resistance program are as follows:

Table 4. Comparison of Theory Calculation with Maxsurf Calculation

No	Data	Theory	Maxsurf	Difference
1	Vol. Displacement (m^3)	2.651 m^3	2.65 m^3	0 %
2	Cwp	0.914	0.868	5 %
3	S (m^2)	13.363 m^2	13.211 m^3	0 %
4	Resistance (kN)	1.39 kN	1.4 kN	0 %

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5	Power BHP (Hp)	10.902 Hp	11.245	3 %

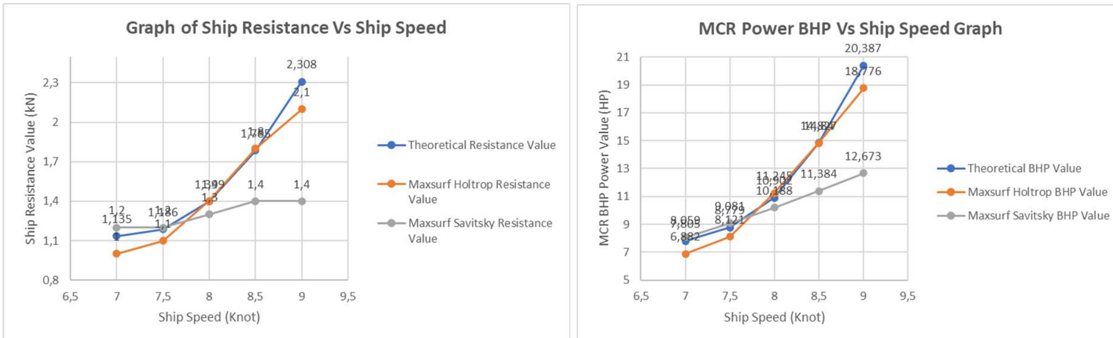

Figure 5. Graph of Relationship between Ship Speed (Knot), Ship Resistance (kN), and BHP MCR (HP)

The meaning of results of the graph above shows that the ship's speed is directly proportional to the ship's resistance as well as the power needed on the ship. If the higher the speed of a ship, it will also produce BHP resistance and power required by the ship. The graph above shows that the power value in the maxsurf resistance program is the result of multiplying the total efficiency of BHP - SHP.

3.2. Testing Fuel Consumption & Speed of 3 GT Vessel with Yamaha E15CMHL Outboard Engine

At this stage, the testing process is carried out by taking data in the waters of Tlocor village, Sidoarjo, East Java. To obtain data on fuel consumption values and ship speed based on RPM on the Engine. In this process the Free Running Test method is used as a test, in this method the condition of the engine rotation or RPM and the position of the rudder must be constant. In this test, a loading or load of 25% (438,389 Kg), 50% (575,789 Kg), and 100% (888,189 Kg) is used where the loading has been added to the weight of the ship of 282,089 Kg, with engine speed values of 2000, 3000, 4000, and 5000 RPM.

Table 5. Data Processing Results Speed and Fuel Consumption on Yamaha E15CMHL Engine Load 25%, 50%, and 100%

Load	RPM	Running 1		Running 2		Running 3		Rata-rata	
		Vs (Knot)	FC (Ltr/hr)	Vs (Knot)	FC (Ltr/hr)	Vs (Knot)	FC (Ltr/hr)	Vs	FC
25% 438.38kg	2000	5.716	4.5	5.716	4.5	5.114	4.71	5.515	4.57
	3000	6.478	4.17	6.702	3.7	5.716	4.21	6.299	4.02
	4000	7.198	5.97	7.198	3.31	6.702	4.96	7.033	4.74
	5000	7.476	8.28	7.476	8.28	7.476	7.59	7.476	8.05
Load	RPM	Running 1		Running 2		Running 3		Rata-rata	
		Vs (Knot)	FC (Ltr/hr)	Vs (Knot)	FC (Ltr/hr)	Vs (Knot)	FC (Ltr/hr)	Vs	FC
50% atau 575.78kg	2000	4.519	4.6	4.626	5.14	4.319	4.39	4.488	4.710
	3000	5.553	5.65	6.268	5.79	5.889	5.43	5.903	5.623
	4000	6.074	7.84	5.889	10.9	6.478	7.2	6.147	8.647
	5000	6.074	7.3	7.198	9.32	6.268	6.96	6.513	7.860
Load	RPM	Running 1		Running 2		Running 3		Rata-rata	
		Vs (Knot)	FC (Ltr/hr)	Vs (Knot)	FC (Ltr/hr)	Vs (Knot)	FC (Ltr/hr)	Vs	FC
100% atau 888.18kg	2000	5.252	3.38	4.416	2.44	4.049	3.74	4.572	3.187
	3000	6.941	7.05	6.478	4.17	5.398	5.99	6.272	5.739
	4000	6.941	6.4	6.478	6.58	6.074	5.06	6.498	6.014
	5000	7.775	8.64	6.941	7.05	6.702	9.28	7.139	8.323

3.3. Testing Fuel Consumption & Speed of 3 GT Vessel with Yamaha E25BMHL Outboard Engine

Table 6. Data Processing Results Speed and Fuel Consumption on Yamaha E25BMHL Engine Load 25%, 50%, and 100%

Load	RPM	Running 1	Running 2	Running 3	Rata-rata

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		Vs (Knot)	FC (Ltr/hr)	Vs (Knot)	FC (Ltr/hr)	Vs (Knot)	FC (Ltr/hr)	Vs	FC
25% 438.38kg	2000	6.075	2.811	5.889	3.272	5.889	3.052	5.951	3.045
	3000	6.075	5.061	5.889	4.035	6.074	3.934	6.013	4.343
	4000	6.702	6.206	6.268	3.6	7.198	5.997	6.723	5.268
	5000	8.098	9.748	7.775	9.36	8.098	8.247	7.990	9.118
Load	RPM	Running 1		Running 2		Running 3		Rata-rata	
		Vs (Knot)	FC (Ltr/hr)	Vs (Knot)	FC (Ltr/hr)	Vs (Knot)	FC (Ltr/hr)	Vs	FC
50% 575.78kg	2000	5.716	5.821	5.398	3.999	5.553	4.32	5.556	4.713
	3000	6.075	5.061	6.478	3.6	6.478	4.197	6.344	4.286
	4000	6.268	6.386	6.702	5.583	6.268	4.644	6.413	5.538
	5000	6.478	7.797	7.775	9.36	7.476	7.614	7.243	8.257
Load	RPM	Running 1		Running 2		Running 3		Rata-rata	
		Vs (Knot)	FC (Ltr/hr)	Vs (Knot)	FC (Ltr/hr)	Vs (Knot)	FC (Ltr/hr)	Vs	FC
100% 888.18kg	2000	5.534	2.57	5.716	3.175	5.114	4.734	5.455	3.493
	3000	6.075	4.723	5.889	4.906	6.074	3.934	6.013	4.521
	4000	6.478	7.797	6.702	8.812	6.268	7.545	6.483	8.051
	5000	7.198	11.332	7.198	10.663	7.746	11.073	7.291	11.023

3.4. Technical Comparison Between the Use of Yamaha E15CMHL Outboard Engine and Yamaha E25BMHL Outboard Engine

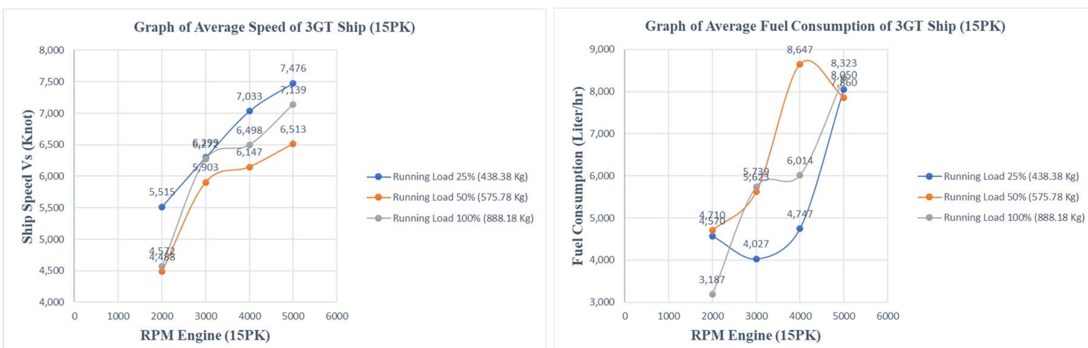

Figure 8. Graph of Average Speed Value and Fuel Consumption of 3GT Fishing Boat with Yamaha E15CMHL Outboard Engine

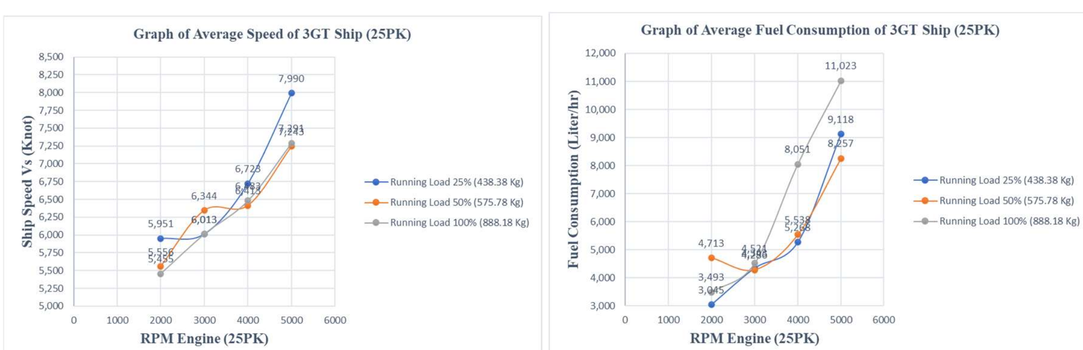

Figure 9. Graph of Average Speed Value and Fuel Consumption of 3GT Fishing Boat with Yamaha E25BMHL Outboard Engine

The graph above, shows the average value recorded from the test results that have been carried out using Yamaha E15CMHL and Yamaha E25BMHL outboard engines, in terms of the speed of the ship traveled and the results of fuel consumption required at each given loading. In a technical review based on the calculation of ship resistance and the required engine power, in the previous explanation of the calculation of ship resistance that the value of the resistance of a 3 GT fishing boat is 1.39 kN (theoretical calculation) and 1.4 kN (maxsurf

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software calculation) with a ship speed planning of 8 knots, so that the engine power capacity of 10,902 HP (theoretical calculation) and 11,245 HP (maxsurf software calculation) is needed. So it can be concluded that the capacity of engine power requirements needed by a 3 GT fishing boat in terms of ship resistance calculations, the Yamaha E15CMHL outboard engine of 15 HP is more technically suitable than the Yamaha E25BMHL outboard engine of 25 HP.

Based on the BKI rules section 8 vol. I edition 2022 concerning domestic ship regulations, that the speed of domestic ships must be able to operate at a minimum speed of 7 knots. In the regulations set by the Ministry of Maritime Affairs and Fisheries (KKP) regarding the determination of the speed of fish transport vessels ranging from 7 - 8 knots. This is in accordance with the statement (Anandi, 2012) that ship speed is also influenced by the efficiency of the engine used. In addition, the speed of the ship is also determined by the condition of the cargo on it, because the ship's cargo is increasing, the draft of the ship will also increase, which means that the ship's resistance will also become greater.

Analysis of ship speed based on the test results contained in the graph obtained average speed at 5000 RPM using Yamaha E15CMHL outboard engine obtained 7.476 knots in 25% loading condition, 6.513 knots in 50% loading condition, and 7.139 knots in 100% loading condition. In the graph, the average ship speed at 5000 RPM using the Yamaha E25BMHL outboard engine was obtained at 7,990 knots under 25% loading conditions, 7,243 knots under 50% loading conditions, and 7,291 knots under 100% loading conditions. The test results in graphs 8 and 9 show that the two engines produce almost the same average speed, which can reach a ship speed of around 7 knots when operating at 5000 RPM. So, when compared to the BKI regulations, the Ministry of Marine Affairs and Fisheries (KKP) regulations, and Anandi's statement in his journal mentioned above, it can be concluded that the Yamaha E15CMHL outboard engine is technically more suitable for use on 3 GT fishing boats.

The next analysis is reviewed in terms of fuel consumption requirements between Yamaha E15CMHL and Yamaha E25BMHL outboard engines. According to (Suzuki, 1978) that the addition of engine power must be proportional to the load given in the sense that if the speed given to the load exceeds the required speed will result in the ship being inefficient, this is because the addition of thrust (HP) more than the appropriate speed not only results in the engine being used too heavy and large but will result in higher fuel consumption without any significant change in speed. In graphs 8 and 9, based on the results of the tests that have been carried out, the amount of fuel consumption required between the two engines shows a significant difference, where the two engines operated at 5000 RPM have similar average speed results, with a fuel consumption value of 8.323 liters / hr for Yamaha E15CMHL outboard engines and 11.023 liters / hr for Yamaha E25BMHL outboard engines. So, it can be concluded that the Yamaha E15CMHL engine is technically more suitable for use on 3 GT fishing boats both in boat speed and total fuel consumption,

3.5. Analysis of Break Even Point (BEP) Value Between Yamaha E15CMHL and E25BMHL Outboard Engine

Economic analysis is reviewed in terms of investment costs required, operational costs incurred, and compared to the results of fishermen's income obtained. Inventation costs are the amount of costs required for machinery needs as a boat mover. Operational costs include fuel needs and abk costs. In economic analysis using the Break Even Point (BEP) method.

Break Even Point (BEP) of Yamaha E15CMHL outboard engine:

Investment cost requirement	= Rp. 31,920,000
Operating cost requirement	= Fuel cost + Side oil
	= Rp. 1,020,000 + Rp. 250,000
	= Rp. 1,270,000/day
Total income of fishermen	= Rp. 2,000,000/day

$$BEP = \frac{Rp.31.920.000}{(Rp.2.000.000-1.270.000)}$$

= 44 days

Break Even Point (BEP) of Yamaha E25BMHL outboard engine:

Investment cost requirement	= Rp. 42,120,000
Operating cost requirement	= Fuel cost + Side oil
	= Rp. 1,320,000 + Rp. 350,000
	= Rp. 1,670,000/day
Total income of fishermen	= Rp. 2,000,000/day

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$$BEP = \frac{\text{Rp.42,120,000}}{(Rp.2.000.000-1.270.000)}$$
$$= 128 \text{ days}$$

4. Conclusion

Conclusions that can be drawn from the analysis and discussion of the technical and economic analysis of the use of Yamaha E15CMHL outboard engines as a 3 GT fishing boat propulsion in Tlocor village, as follows:

1. From the results of the calculation of the resistance value of a 3 GT fishing boat using the Holtrop method is worth 1.39 kN, with a comparison of the resistance value using Maxsurf Resistance software worth 1.40 kN which has a correction value of 0.007%.
2. From the test results and technical analysis, it is concluded that technically the Yamaha E15CMHL outboard engine is more suitable to be used for 3 GT fishing boats. In terms of ship speed, the Yamaha E15CMHL outboard engine with a power of 15 HP is able to reach an average ship speed of 7.139 knots at 5000 RPM load 888.18 kg and has a fuel consumption of 8.323 liters / hr. This is in accordance with the rules of BKI part 8 vol. I edition 2022 concerning domestic ship regulations and regulations set by the Ministry of Maritime Affairs and Fisheries (KKP) regarding the determination of the speed of fish transport vessels ranging from 7 - 8 knots. Compared to using a Yamaha E25BMHL outboard engine with a power of 25 HP which reaches an average speed of 7.291 knots at 5000 RPM load 888.18 kg and has a fuel consumption of 11,023 liters / hr.
3. From the results of the BEP (Break Even Point) calculation as an economic analysis, it is concluded that the economic value of the Yamaha E15CMHL outboard engine is more suitable for 3 GT fishing boats. The BEP value of the Yamaha E15CMHL outboard engine is 44 days, while the BEP value of the Yamaha E25BMHL outboard engine is 128 days. Thus, economically, the Yamaha E15CMHL outboard engine has a turning point value or break-even point 84 days faster than the Yamaha E25BMHL outboard engine.

Credit authorship contribution statement

Author Name: Conceptualization, Writing – review & editing. **Author Name**: Supervision, Writing – review & editing. **Author Name**: Conceptualization, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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