February 28, 2023

Resistance of Fishing Ship That Based on Bitung Coastal Area

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Received Date: 13-Nov-2022 **Accepted Date: 23-Dec-2022** **Published Date: 28-Feb-2023**

Abstract.
The type of fishing vessel that is widely used by fishermen in North Sulawesi, especially in the Bitung Coast, is a pelagic fishing vessel. When the ship sails at a certain speed, it will experience resistance in the form of resistance. This resistance will cause some speed drops. This will result in losses to the ship, including the time it takes when the ship performs maneuvers to catch schools of fish, extending the sailing time so that fuel consumption becomes greater and the use of working hours becomes longer, which means the cost of exploitation of the ship becomes greater.
The purpose of this research is to study the resistance of fishing vessels and to explain the impact of the coefficient of vessel shape on vessel resistance and after being given various treatments.
From the results of this study, it can be explained that the beam coefficient (Cb) of the ship model in Bitung Coast which was treated with trim is 0.54 which means that the volume of the submerged in the water column is 54 of the volume of the ship in the form of a beam. Thus, the ship's body tends to be thin/slim, so that when the ship is run, the ship does not get too much detention.
Likewise, the prismatic coefficient (Cp) for the ship model in various trim variations is 0.72 which means that the displacement volume is 72 percent of the volume of the ship model as the product of the cross section of the middle of the ship with the length of the ship, the ship model has a tendency the cross section towards the bow and aft is increasingly equal to the cross section of the center of the model ship. For the coefficient of the middle cross section ($C_{\otimes}$) of the ship model in various trim variations is 0.60, which means that the middle sectional area of the ship model is 60 percent of the cross sectional area of the ship model in the form of four squares. From the average value of the coefficient of water field (Cw) for ships in various trims is 0.79 which means that the area formed by the water line in various trim variations for ship models tends to be close to a rectangular shape. This also shows that the opening of the ship's wall from the stern to the bow is getting smaller.
The total resistance of the ship model (RTM) is small as well as seen from the different trims, which start from trim -1º, 0º, 1º, 2º from the lowest speed to the highest speed. The frictional resistance for the model vessel at various trim variations for all current speeds shows that the value of the frictional resistance of fishing vessels is small as seen from the wet surface area (S) as well as for the residual resistance.
Keywords: *Ship resistance, ship trim, ship coefficient*

Introduction

In order to increase fishery production, especially in the field of capture fisheries, by utilizing sustainable fisheries resources in an optimal and integrated manner, the use of appropriate technology to manage fishery resources must be supported by adequate facilities. One of the main facilities that support the management of marine resources is fishing vessels. Nomura and Yamazaki (1977), stated that based on its main function, fishing boats have characteristics that are characteristic such as high speed, seaworthy, wide sailing range, strong structure, proper engine installation, fishing equipment equipment. and others. Fishing vessels owned by fishermen operating in the waters 12 miles of the North Sulawesi coastline are increasing along with the increasing market demand. Small purse seine is a type of pelagic fishing vessel that is widely used by fishermen in North Sulawesi. When the ship sails at a certain speed, it will experience resistance in the form of resistance. Thus, this resistance will cause some speed to drop. The ship's resistance at a speed is the fluid force acting on the ship in such a way that it opposes the motion of the ship (Harvald, 1992). Meanwhile, according to Djatmiko et al. (1983), the ship's resistance is the opposing force due to the thrust of the propellers. Thus it can be said that the resistance is the resistance experienced by the ship at a certain speed where the resistance will affect the speed of the ship. The ship's resistance consists of two main components, namely frictional resistance (Rf) and residual resistance (Rr). The amount of total resistance of a ship can be determined through the model expressed by the formula proposed by Froude in Harvald (1992):

$$Rtm = Rfm + Rrm$$

Where:
Rtm = Total resistance of the model
Rfm = Model friction resistance
Rrm = Residual resistance of the model.

The total resistance of the ship according to Harvald (1992), is seen as something that consists of the components of the forces acting on the ship which can be combined with each other using a variety of different ways. Furthermore, it is also said that to determine the model's total resistance (Rtm) can be measured during the experiment, while the model's frictional resistance (Rfm) can be found using calculations.
As long as the ship is moving, it will always be affected by frictional resistance which is the largest resistance from other prisoners such as air resistance, wave resistance and pressure resistance (Yamamoto in Sala, 1988). It is known that the frictional resistance depends on the wet surface area of the vessel, the quality or roughness of the wet surface of the vessel, the speed of the vessel and the viscosity of the fluid medium itself. Furthermore, it is also said that residual resistance includes wave resistance, viscous pressure resistance and additional frictional resistance. Meanwhile, according to Djatmiko et al. (1983), residual resistance includes wave resistance, pressure resistance and air resistance.
On ships that are sailing, it is often found that the hull of the ship that is immersed in the water at the bow is not the same as the stern. The difference between bow laden and stern laden is termed trim.

Material and Methods

A. Research Method

This research is an experimental research that describes systematically, factually and accurately about the facts and properties of certain objects (Suryabrata, 1994). The main dimensions of the ship are Length = 16.68 ; Width (Breadth) = 2.85 ; In (Depth) = 1.21 with each coefficient is Cb = 0.56 ; Cp=0,85 ; $C_{\otimes}$ = 0.67 and Cw= 0.83.

B. Data Collection Techniques

Data collection techniques were carried out through direct observation and measurement, interviews and making models that were tested to obtain primary data, quoting information from several scientific papers according to the research topic to obtain secondary data.

To make the model of the ship being tested, measurements of the main dimensions of the ship are carried out, while the main dimensions of the ship needed are as follows:

a. LOA (Length Over All)

LOA is the horizontal distance from the stern of the ship to the bow or is the overall length of the ship and its variations.

b. LBP (Length Between Perpendicular)

LBP is the length of the ship measured from FP (Fort Perpendicular) to AP (After Perpendicular).

c. Bm (Breath mold)

Bm is the width of the widest ship measured up to the outer shell of the ship.

d. D (Depth)

D is the vertical distance from the base line to the freeboard deck line at the widest part of the ship.

e. d (draft)

d, namely in the ship's submerged (laden) measured from the base line to the waterline.

C. Materials and Tools

The object of this research is a fishing vessel, a small purse seine based on the Bitung coast, which is measured and then its design is drawn. The ship was measured and then redrawn the design followed by making a model with a scale reduction of 1:20. From the existing designs, a ship model is then made which is then tested in a tank test (tank test).

The prototype ship model is based on the shape of the ship, namely fat, slender and plump. The coefficient that describes this condition is called the shape coefficient which consists of the beam coefficient, prismatic coefficient, middle section coefficient and water plane coefficient.

Based on the main dimensions of this prototype ship, a fishing vessel model with the same length was made and two vessels representing the location were taken, namely in Bitung as a benchmark through a 1:20 scale reduction as a practical and economical consideration.

D. Data Collection Techniques

Data on the maximum speed of the ship and the length of the ship, will get the maximum speed of the model ship by using the ratio of speed and length of the ship V/□L as stated by Harvald (1992).

The current speed measured in the experimental tank is 8 pieces, namely from 0.23 m/s to 0.41 m/s, with the assumption that the speed of the water flow is the speed of the model ship.

Data collection techniques were carried out through direct observation, measurement and recording. Data collection to find the total resistance of the ship is done by measuring the resistance of the ship model at several current speeds formed by the rotation of the propeller in the experimental tank and carried out under various trim conditions. The total resistance here is only caused by water, while the resistance by air is considered not to affect the total resistance of the model.

E. Data Analysis Techniques

To get a clear picture of the ship's resistance based on the treatment, the results of the observations are described in terms of the relationship between the ship's resistance (ordinate axis) at various speeds/Froude numbers (abscissa axis).

The formulation of the Froude number (Fn) according to Harvald (1992) is as follows:

$$Fn=\frac{V}{\sqrt{g.L}}$$

Where: V = Velocity(m/s)

g = Gravity(9.8m/s)

L = Length of ship/model (m)

To determine each form coefficient, the formulas proposed by Comstock (1967) are used.
Then to determine the effect of size and shape coefficient on ship resistance due to varying trim treatments, it can be searched by eliminating the middle section coefficient ($C_{\otimes}$) and the volume of the ship immersed in water/displacement (∇) in the shape coefficient formulas proposed. by Comstock (1967).
Then to find the value of frictional resistance, the formula proposed by Froude in Harvald (1992):

$$RFM=\frac{\gamma\lambda}{1000}\times SV^{1,825}$$

Where: = Density of water
V = Speed (m/s)
S = Wet surface area (m2)

Meanwhile, to find the value of , the formulation proposed by Besnerais in Harvald (1992):

$$\lambda=\frac{0,258}{2,68+L}\times 0,1392$$

Where: L = Length of ship/model (m)

Results and Discussion

A. Coefficient of Fineness

The ship shape coefficient is a measure that describes the slenderness and slenderness of the ship in the water column. The results of this study can be seen in Table 1 below:

Table 1. Coefficient of Model Ship Shapes in Various Trim Variations.

Model Ship	Trim (°)	Coefficient of Shape			
		Cb	**Cp**	**$C_{\otimes}$**	**Cw**
	-1	0,54	0,74	0,73	0,80
	0	0,54	0,73	0,74	0,79
	1	0,54	0,72	0,75	0,79
	2	0,54	0,71	0,76	0,79
Average		0,54	0,72	0,74	0,74

1. Block coefficient (Cb)

From the average beam coefficient value for the two ship models that have been given different trim treatments, it is 0.54 for the model ship based on the Bitung coast so it can be explained that the volume of the submerged in the water column of the model ship is 54 percent of the volume of the ship in the form of beam. Thus, the ship's hull model tends to be thin/slim so that when the ship is running it does not get resistance from liquid fluids when compared to ship models that have a fat shape. This result is related to the explanation put forward by Suzuki (1978), that the smaller the beam coefficient value, the thinner the ship is.

2. Prismatic coefficient (Cp)

From the average value of the prismatic coefficient for model ships in various trim variations, it is 0.72 for model ships, which means that the volume of the ship's submerged is 72 percent of the volume of the model ship. Thus, the greater the value of the prismatic coefficient will cause the cross section towards the bow and stern of the model ship to be more the same as the cross section of the middle of the model ship, so that it can be concluded that the model ship has a tendency to cross section towards the bow and stern more the same as the middle cross section of the model ship.

3. Mid-Ship coefficient ($C_{\otimes}$)

From the average value of the coefficient of the middle cross section of the ship in various variations is 0.74, which means that the middle cross-sectional area of the ship is 74 percent of the cross-sectional area of the ship in the form of a square.

4. Water-Plane coefficient (Cw)

From the average value of the coefficient of water field for model ships in various trim variations is 0.79 for Aldeis ships, which means that the area formed by the water line in various trim variations for both ship models tends to approach a rectangular shape. This also shows that the opening of the ship's wall from the stern to the bow is getting smaller

B. Resistance of Ship Model

1. Total Resistance of Ship Model (RTM)

The total resistance of the ship model in various trim variations can be found by experiment (Harvald, 1992). From the results of research conducted to find the total resistance of the ship model (RTM) (gr) for several current flow speeds which in this case is considered the speed of the ship model in various variations of different trim, the total resistance value of the two ship models is obtained after being averaged. average can be seen in the following table:

Table 2 Vessel speed in various trim

Speed (m/s)		Trim (°)			
		-1	**0**	**1**	**2**
V.1	0,23	2,58	2,04	3,40	4,54
V.2	0,26	2,60	2,22	3,56	4,56
V.3	0,27	3,02	2,26	3,64	4,70
V.4	0,28	3,22	2,44	4,08	4,80
V.5	0,31	3,48	2,52	4,16	6,78
V.6	0,32	4,96	4,36	5,48	7,68
V.7	0,39	5,66	5,02	7,70	11,28
V.8	0,41	7,16	5,98	8,24	11,78

From the table above, the total resistance values are then plotted into a graph for each trim at several current speeds which in this case is considered the ship model speed and can be seen in Figures 1 and 2, in order to make it easier to analyze the total model resistance. the ship.

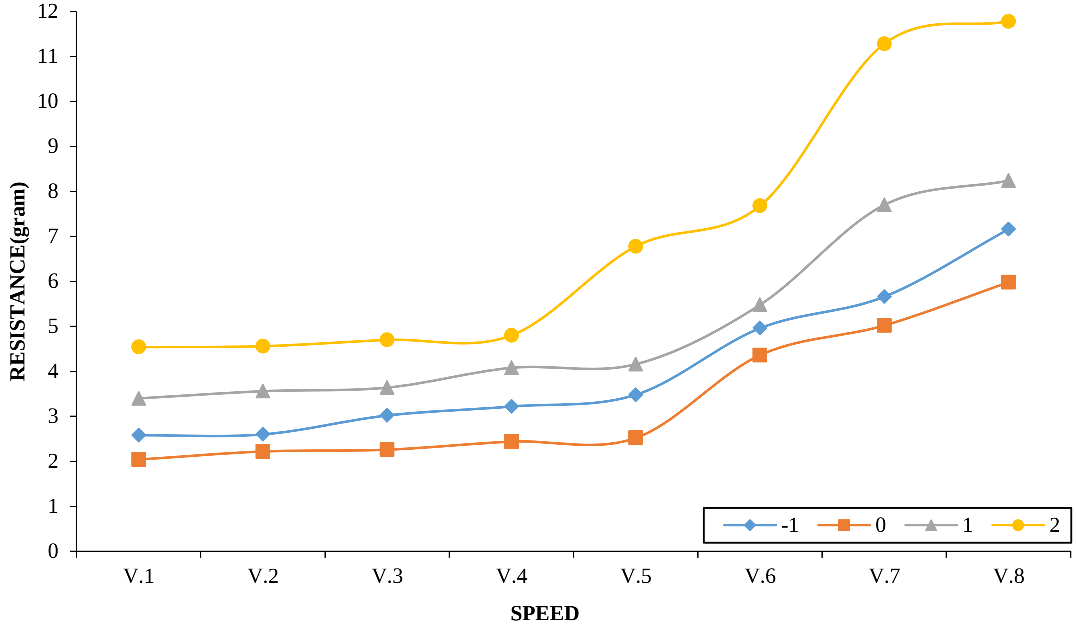

Figure 1. Graph of Total Resistance (grams) Against Speed on Model Ships

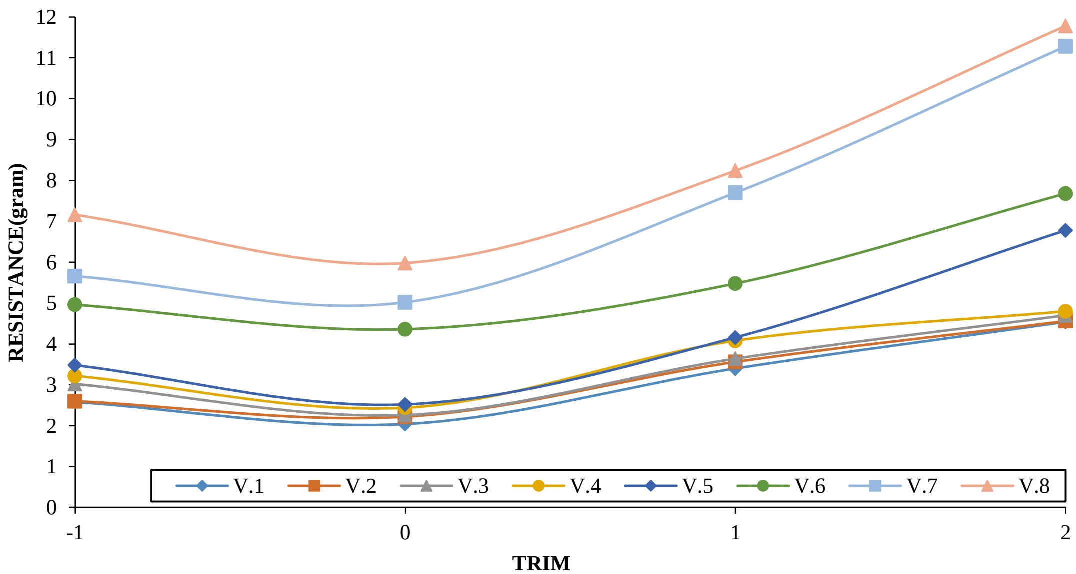

Figure 2. Graph of Total Resistance (grams) Against Trim on Model Ships

From the graph above, it can be seen that the total resistance value of fishing vessels has increased. Likewise, seen from different trims, where from trim -1º, 0º, 1º and 2º from the lowest speed to the highest speed, all of them show an increase in the total resistance. Likewise with the value of the prismatic coefficient. This shows that the cross section from the bow and stern direction towards the midship or in other words that the shape of the ship tends to approach a box / square shape, resulting in a larger total resistance value.

2. Model Friction Resistance (RFM)

Harvald (1992) states that frictional resistance can be found through calculations using the formula proposed by Froude, namely:

$$RFM=\frac{\gamma\lambda}{1000}\times SV^{1,825}$$

From the results of this study obtained the value of frictional resistance for the ship in various trim variations which can be seen in the following table:

Table 3. Wet Surface Area.

Ship Model	Trim (°)	S (m^2)
	-1	46.50
	0	46.10
	1	45.90
	2	45.57

Table 4. Friction Resistance of Ship Model, RFM (grams) In Various Trim Variations.

Ship Model:					
Speed (m/s)		Trim (°)			
		-1	**0**	**1**	**2**
V.1	0,23	0,49	0,48	0,48	0,48
V.2	0,26	0,63	0,62	0,62	0,62
V.3	0,27	0,68	0,67	0,67	0,67
V.4	0,28	0,71	0,70	0,70	0,69
V.5	0,31	0,82	0,82	0,82	0,81
V.6	0,32	0,91	0,91	0,90	0,90
V.7	0,39	1,27	1,26	1,25	1,25
V.8	0,41	1,44	1,43	1,42	1,41

The frictional resistance values contained in the table above are then plotted into the following graph, to make it easier to analyze the frictional resistance, RFM of the two ship models.

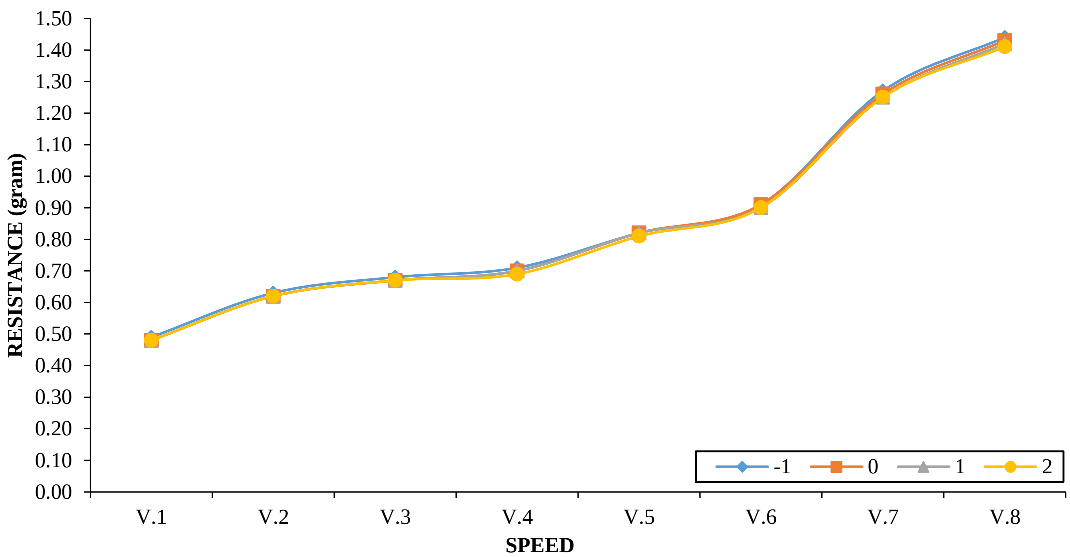

Figure 3. Graph of Model Frictional Resistance, RFM (grams) Against Model Ship Speed

From the graph of frictional resistance, RFM (grams) above, it can be explained that the value of the frictional resistance of the model ship at various trim variations for all current speeds as well as from the wet surface area (S)

According to Harvald (1992), the residual resistance of the model can be found using the formula RRM=RTM-RFM. From the results of the research conducted, the residual resistance value can be seen in the following graph:

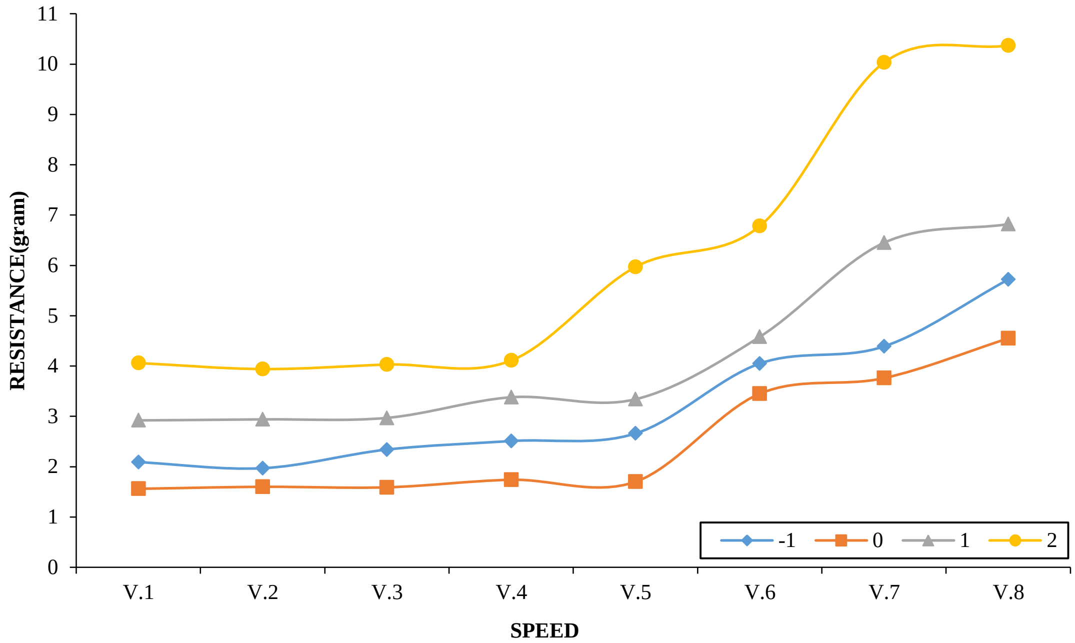

Figure 4. Graph of Residual Resistance (grams) Against Ship Speed

Table 5. Residual resistance of ship model (grams).

Ship Model:					
Speed (m/s)		Trim (º)			
		-1	**0**	**1**	**2**
V.1	0,23	3,09	2,17	3,13	3,49
V.2	0,26	4,07	2,68	4,26	5,04
V.3	0,27	4,34	4,00	5,56	7,15
V.4	0,28	4,98	4,02	5,60	7,23
V.5	0,31	5,34	4,10	5,74	8,57
V.6	0,32	5,42	4,10	7,12	8,51
V.7	0,39	5,66	5,16	7,89	9,33
V.8	0,41	7,36	5,91	8,15	9,48

From the graph of the residual resistance of the ship model and from the results of calculations using the formula proposed by Harvald (1992), for trim -1º, 0º, 1º, at all speeds (m/s) the value is smaller. However, at trim 2º the residual resistance value of the model ship is larger. This is inversely proportional to the small value of frictional resistance, according to the formula proposed by Harvald (1992).

From these results, it can also be explained that at low speeds, the total resistance value produced is low as well as the frictional resistance value is low, but the remaining resistance value is large. This is in accordance with the formula put forward by Froude in Harvald (1992) that the value of the residual resistance depends on the value of the friction resistance, or in other words, if the value of the residual resistance of the model is large, the value of the frictional resistance is small to the total resistance value of the model. In addition, it can also be said that with increasing speed, the frictional resistance will be smaller and the remaining resistance will be greater.

Conclusion

1. The total model resistance (RTM) value of ships on the Bitung coast is small. This is because the beam coefficient value (Cb) of the ship model is 0.54 or 54 percent, which means that the optimization of the ship's effective power tends to be better which causes more efficient fuel consumption.
2. The value of the frictional resistance model (RFM) of the ship is a large value. With increasing speed (m/s) from 0.23 m/s to 0.41 m/s, the resistance of the ship model will be even greater. The greater the value of the total resistance of the model, the greater the value of the residual resistance, otherwise the frictional resistance will be smaller.
3. The total resistance of ship models with different trims shows an increase in the resistance value.

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