Original Article

Resistance Analysis Of Purse Seine Ship Due To Redesign Of Fish Hold In Consideration Of Local Wisdom In Sinjai Regency

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Abstract

carrying out fishing operations. The design of traditional fishing boats with a scientific approach to the hydrodynamic aspects of vessel resistance is carried out in order to ensure the safety of traditional fishing boats. Resistance information will be used as a reference for determining the main and auxiliary engines where the selected engine must match the thrust requirements at a certain speed. In Sinjai Regency, South Sulawesi, information was obtained related to the design of purse seine vessels, there are fish holds that are above the ship's deck. this was done because of the low draft of the ship, so that the impact on the resistance of the ship was not taken into account. This research will redesign the purse seine in Sinjai which has a hatch on the ship's deck without changing the shape of the bow and stern of the purse seine so that it has a better resistance value in two loading conditions, namely empty and fully loaded. The time and place of this research was carried out in January-June 2022 in Sinjai Regency. The sampling method used is a deliberate sampling method. The results showed that the total resistance of the ship was 44319.83 N with an engine power of 423430.25 W at maximum speed (13 knots). That it was concluded that the values before and after the redesign did not experience significant changes or the results obtained were the same as using the maxsurf resistance analysis, but for the samples after the redesign it was better because the hatch above the deck which took part of the area above the deck had been moved down to fill the void below the deck and provide ample space above the deck so that the crew can freely carry out their duties during fishing operations and also allow for a better stability value compared to the ship before the redesign.

Keywords: Redesign, Resistance, Fish Hold, Power, Purse Seine

INTRODUCTION

The national fishing fleet, until now, is still dominated by various types of boats and traditional fishing vessels. Generally, traditional fishing boats are made of wood with a size of <30 GT and are built by shipyards (traditional wooden boat craftsmen) unique to each region. Because of its traditional nature, the reference in the implementation of its construction is not based on complete design drawings and technical specifications, but based on experience that has been passed down from generation to generation and follows the traditional system of the local community (Rahardjo, 2008). So the shipbuilding process uses traditional methods and their trust in technological developments is very low (Trimulyono et al., 2015). Therefore, the process of making traditional fishing boats needs to be brought closer to shipping science and also rules related to ship safety. In addition to safety aspects, several aspects related to ship hydrodynamics are also a serious concern for the development of fishing vessels even though they are built in a traditional way. In addition to studying the hydrodynamic aspects of existing traditional fishing boats, changes and additions to traditional fishing boat design components are also important in the study of hydrodynamic aspects. East Java traditional fishing boats have been analyzed in terms of ship motion performance (seakeeping) where the bilge keel has been designed to reduce rolling motion. With the hull keel design, the ship's resistance and rocking can be reduced (Liu et al., 1995). The suggested approach to designing fishing vessels for specific fishing communities in Indonesia is to use traditional fishing vessels as a starting point in the initial design stage, retaining and adapting features to traditional vessels, ensuring that local identity is maintained (Wibawa et al., 2015).

Regarding the redesign of traditional fishing vessels that consider *local wisdom*, the redesign of purse seine vessels to improve fishing capability has been studied (Ayodhyoa, 1972), where hasil research shows the value of the ratio of the main dimensions of sample vessels = 4.25, = 4.86, and = 1.14. $\frac{L}{B}\frac{L}{D}\frac{B}{D}$Some sample ships from the redesign did not meet the standards of dimensions and ship shape ratios (Iskandar & Pujiati, 1995).

From the explanation above, there are 3 main problems for traditional fishing vessels to survive, develop, and be sustainable in the future, where traditional fishing vessels should consider hydrodynamic aspects including vessel resistance, exhaust emission aspects, and redesign aspects with consideration of local wisdom. And what is meant by local wisdom here is the ship dimensions and ship models that are still being maintained in redesigning traditional ships such as the stern, bow and hull. Redesign is needed to obtain results that can reduce fuel consumption, which is increasingly high according to the statement (Ayodhyoa, 1972). The exhaust emissions of 43 fishing boats exceeded the predetermined threshold in the 11-15 GT and 21-25 GT categories. And the Purse Seine fishing gear in Sinjai Regency uses vessels <30 GT in size. Vessels <30 GT usually base at the Lappa Fish Landing Port (Wibowo et al., 2021). The fisheries sector in Sinjai Regency is indeed very promising. Based on the Statistics of the Sinjai Regency Fisheries Service (2020), in 2019 the total value of production of capture fisheries products in Sinjai Regency is Rp. 44,616,361,170 with a total production of 8,725,376 Kg Development of facilities and infrastructure to support economic growth based on fisheries are urgently needed. Increased production is directly proportional to the increase in facilities and infrastructure so that the Government can maximize the provision of fishing facilities and infrastructure and the needs of fishermen can optimize capture fisheries-based economic development (Wibowo et al., 2021).

Methodology

This research was carried out from January to June 2022. Sampling was carried out at TPI Lappa, Sinjai Regency. Design and redesign of ship samples as well as hydrostatic and resistance analysis using Maxsurf modeler and maxsurf resistance software. The method used in this study is the method of literature, observation and interviews. The object of this research is the purse seine ship in TPI Lappa Sinjai. The data collection technique in this study was a deliberate sampling technique based on ships docked at TPI Lappa Sinjai taking into account the size of the ship. The data analysis used in this study is the resistance and hydrostatic analysis of ships based on IMO standards with the help of Maxsurf Pro Modeller software to carry out ship modeling and Maxsurf Resistance software to carry out the process of analyzing purse seine ship resistance values.

Results and Discussions

Ship Redesign

Prior to modeling on maxsurf, purse seine vessels were measured directly first. The measurement results are presented in table 1.

Table 1 Dimensions of the main dimensions of the purse seine ship at TPI Lappa

Ship	L(m)	B(m)	D(m)	d(m)
Sample	18.30	4.5	1.75	1.45

Based on data on the size of the dimensions of the ship obtained in the field with a length of 18.30meters; width 4. 5 meters; height 1. 75 meters; and *drafts* range between 1. 45 meters. From the results of the size of the main dimension, the ratio value of the main dimension at (Tabel 2) is also obtained.

Table 1 Value of the main dimensional ratio of purse seine vessels at TPI Lappa Sinjai

Ship	L/B	L/D	B/D
Sample	4.07	10. 46	2.57
(Ayodhyoa, 1972)	4.30 – 4.50	10.00 – 11.00	2.10 – 2.15

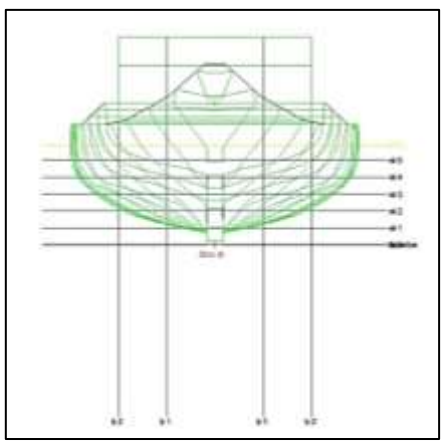
From the main measurement data and sample ratio values of purse seine vessels studied at TPI Lappa, Sinja Regency, it can be said that they are not suitable to support the statement (Ayodhyoa, 1972). In this case the L/B ratio value of the purse seine vessels studied is smaller, namely 4.07 from the standard value set, in accordance with the standard (Ayodhyoa, 1972), namely with the L/B ratio value of 4.30 – 4.50, a ship that is smaller than the standard will result in the magnitude of the motion resistance of the ship so that it will affect the speed of the ship. For adjustments to the standard ratio, it is necessary to reduce the value of B in the sample ship while still paying attention to the value of L to provide good stability to the ship. The L/D ratio value of the purse seine ship sample has a value that is greater than the provisions (Ayodhyoa, 1972), namely the L/D ratio value obtained is 10.46, which means that the elongated strength of the ship is according to the standard. This is due to the D value being able to offset the L value so that the ship will be strong enough against upward and downward bending movements (Ayodhyoa, 1972).

The main dimension B/D ratio value obtained on the purse seine ship sample does not match the figure set by (Ayodhyoa, 1972) where the B/D value is greater than suggested, namely 2.57. This happens because the depth value (D) is low enough so that it does not match the width of the ship. Several studies have also been carried out related to the hydrodynamics of traditional fishing vessels. Stability, resistance and maneuverability of multi-purpose net/line hauler 20 GT fishing vessels have been studied based on the size and shape of the hull of the vessel (Fadillah et al., 2019) Stating, the value of B /d affects a ship's resistance, the greater the value of the ratio, the value of the resistance will tend to be small. In addition, the results of the study stated that the hull resistance of the hard-chine type was smaller than that of the round-U type.

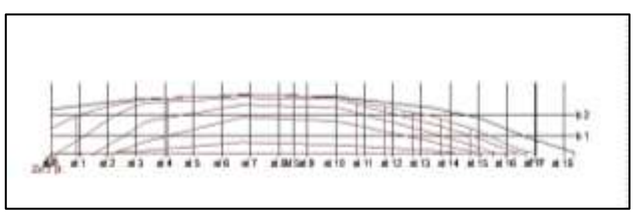
From the results of the ratio values of the sample ships, it was found that the ratio values did not match the standard values (Alfarisi, 2016), this happened because shipbuilding was not based on naval architect calculations. In addition, the lack of knowledge of ship craftsmen regarding the suitability of the size of the ship with the fishing gear used will affect the determination of the main size of the ship to be made.

Purse Seine Lines Plan

Lines plan is an image in the form of a ship line plan made on each waterline and ordinate using the maxsurf application. The lines plan of the purse seine vessels studied are generally divided into several longitudinal ordinates along the ship's hull with a distance of one meter for each ordinate. This lines plan is the main key to the success of the design before the model is analyzed for hydrodynamics, structural strength and further detailing. The basis for building a model on the Maxsurf Modeller uses a surface (such as a carpet) that can be stretched and stretched so that it can become a complete model (Betley system, 2013). This figure also shows the buttock line, which is a line parallel to the center line. The results of the depiction of the purse seine ship's lines plan can be seen in Figures 1 and 2. These images show the shape of the ship's hull in the V-shaped bow where the shape of the bow is slender. This can make it easier for the ship to split the mass of water in front of the ship when moving so that the ship can go at high speed. At the stern of the U-shaped ship, this shape allows the ship to have resistance that is not too large, the ability to split waves is quite good, and allows maximum volume of space.



1A



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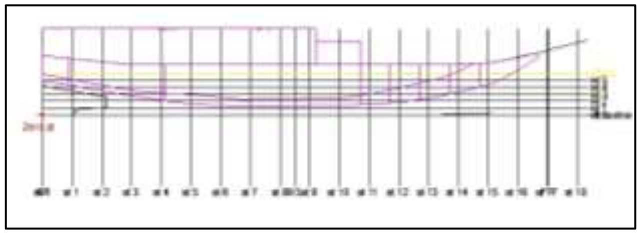
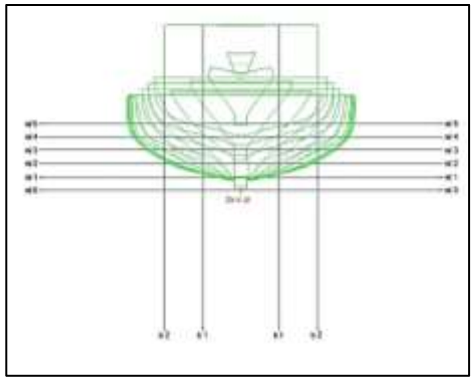
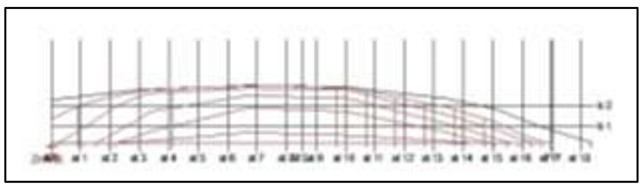


1C

Figure 1 Ship linesplan before reddesign front view (1A) top view (1B) and side view (1C)



2A



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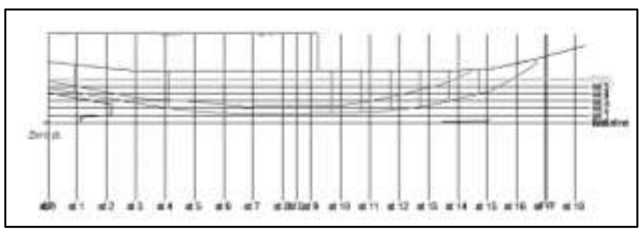


2C

Figure 2 Lines plan ship after reddesign front view (2A) top view (2B) and side view (2C)

From the line plane drawings above both before redesign and after reddesign there are only differences regarding the hatch building which is above the ship's deck. This is because no changes in dimensional values have been made to the ship so that the shape of the stern and bow of the ship remains the same, namely the shape of the ship's hull on V-shaped bow and U-shaped stern.

The Hydrostatic Quantity of A Purse Seine Vessel

Hydrostatic calculations are used to obtain ship characteristics for each variant of the ship model. This is done to see the influence of the position parameters and the shape of the ship. The hydrostatic parameter values include volume displacement, tons displacement, waterplan area, midship area, coefficient of fineness, tons per centimetre immersion, longitudinal center of buoyancy etc. The values of these hydrostatic parameters reflect the ship's static performance (Gillmer and Johnson 1982; Rawson and Tupper 1985; Fyson 1985). The hydrostatic running results on WL 5 using the maxsurf modeler yield values:

Table 3 Ship's hydrostatic magnitude

Parameter m	**Before redesign**		**After redesign**	
	Empty payload	**Full charge**	**Empty payload**	**Full charge**
Displacement t	31,24	47,63	31,24	47,63
Waterpl. Area m^2	52,445	57,421	52,445	57,421
Prismatic coeff. (Cp)	0,612	0,648	0,612	0,648
Block coeff. (Cb)	0,376	0,442	0,376	0,442

Max Sect. Coeff area. (Cm)	0,616	0,684	0,616	0,684
Waterpl. Coeff area. (Cwp)	0,751	0,792	0,751	0,792
LCB from zero pt. (+ve fwd) m	8,031	7,887	8,031	7,887
LCF from zero pt. (+ve fwd) m	7,615	7,66	7,615	7,66
KB m	0,788	0,967	0,788	0,967
KG m	1,161	1,523	1,161	1,418
BMt m	1,821	1,405	1,821	1,405
BML m	28,812	23,264	28,812	23,264
GMt m	1,448	0,922	1,448	0,922
GML m	28,439	22,781	28,439	22,781
KMt m	2,609	2,372	2,609	2,372
KML m	29,6	24,231	29,6	24,231
Immersion (TPc) tonne/cm	0,538	0,589	0,538	0,589

The hydrostatic parameter values include volume displacement, tons displacement, waterplan area, midship area, coefficient of fineness, tons per centimetre immersion, longitudinal center of buoyancy etc. The values of these hydrostatic parameters reflect the ship's static performance (Gillmer and Johnson 1982; Rawson and Tupper 1985; Fyson 1985). In accordance with the nature of hydrostatic pressure, the hydrostatic pressure below the surface of the liquid will be greater. So it can be said that the more water that is above the flat surface, the greater the pressure on the flat surface. The pressure due to the influence of the earth's gravitational force is called hydrostatic pressure.

Ton displacement (Δ), Based on the hydrostatic value obtained, Ton displacement (Δ) indicates the weight of the ship's body below the waterline or describes the weight of water displaced by the immersed hull. The greater the ton displacement value of a ship, the higher the part of the ship that is immersed below the water surface. The ton displacement value of the ship when the load is empty is 31.24 and the ton displacement value when the ship is full is 47.63 tons in WL 5. These values are the maximum load capacity that can be accommodated by the ship. Waterplane area. In the hydrostatic results table, it can be seen that there is no change in the value of the ship before and after the discharge, but there are differences in the empty and full load conditions. At each increase in draft, the value of Aw increases. The area of the ship in an empty condition is 52.44 m2 while in a full condition it is 57.42 m2. Longitudinal center of buoyancy, the distance to the buoyancy pressure point decreases with increasing draft. The LCB value of empty cargo is 8.03 m and 7.88 m of full load. This shows that the higher the draft of the ship, the LCB of the ship will be increasingly towards the stern of the ship, this is due to the increasing volume of ships at the stern. Longitudinal center of floatation, the distance to the center of floatation increases with increasing draft. The LCF value of empty cargo is 7.61 m and 7.66 m full. This shows that the higher the draft of the ship, the LCF of the ship will be directed towards the bow of the ship. This may be due to the influence of the longer LWL. The LCF point is towards the stern of the LCB point. This makes the LCF and LCB points increasingly coincide with the increase in the ship's draft. Keel to longitudinal metacenter height (KMl) is the metacenter height extending to the keel of the ship for each ship's draft. The KMl value of fully loaded ships is 29.60 m and fully loaded is 24.23 m. It can also be seen that in the table the values decrease as the ship's draft increases. This can mean that the higher the draft of the ship, the less the ship's nod. Keel to transverse metacenter height (KMt) is the transverse metacenter height of the keel for each ship's draft. The KMt value will decrease as the draft of the ship increases, on a 1 KMt ship an empty load is 2.60 m and a full load is 2.37 m. This can explain that the more the draft of the ship, the smaller the roll of the ship. Tons per centimeter (TPc), Shows the weight needed to change the draft by 1 cm. The TPC value on an empty ship is 0.538 tons/cm while a fully loaded sample ship is 0.619 tons/cm. This means that adding or reducing cargo to or from inside the ship will increase or decrease the ship's draft by 1 cm.

From the results of the hydrostatic analysis, both the sample ships before redesign and after redesign have the same hydrostatic value in the two loading conditions, whether empty or full. This is because the ship redesign process does not change the shape of the hull, so what makes the hydrostatic value different is only the effect of the ship's cargo (empty and full load).

Coefficient of Purse Seine sample ship form at TPI Lappa

The coefficient of fineness which is commonly referred to as the fatness coefficient of the ship, is one of the hydrostatic parameters that reflects the shape of the ship hull. (Alfarisi, 2016) that ships can be slender or fat, depending on the size of the ship shape coefficients such as beam coefficient (Cb), center section coefficient (Cm), waterline coefficient (Cw) and prismatic coefficient (Cp).

Table 7 Coefficient of fineness of the sample vessel in empty cargo conditions

Ship	Cb	Cm	Cw	Cp

Sample	0,376	0,616	0,751	0,612

Table 8 Coefficient of fineness of the sample vessel in full load condition

Ship	Cb	Cm	Cw	Cp
Sample	**0,442**	**0,684**	**0,792**	**0,648**

The value of Cb moves from 0 – 1, getting closer to the value of 1, the ship is said to be getting fatter and conversely it is said to be lean if it is close to the value 0. The Coefficient block (Cb) value on an empty sample ship is 0.376 and on a full load is 0.442 at WL 5, p. This illustrates that the sample ship has a slender hull shape so that it is advantageous in terms of ship speed. The coefficient of midship (Cm) is the ratio of the cross-sectional area of a large ivory that is submerged in water to the area of a cross-section with width B and height D. The value of the Coefficient of midship (Cm) on the sample ship for empty cargo is 0.616 and for full cargo it is 0.684 at WL5 , this shows that in the midship part of the sample ship it has a round bottom shape. The coefficient water plan (Cw) shows the large longitudinal cross-sectional area amidships compared to the rectangular area surrounding the area, where the value of the Coefficient water plan (Cw) on the sample ship with an empty load condition is 0.751 and a full load pad is 0.792 on WL 5, this shows that the sample ship has a cross-sectional shape of the waterline that is close to a rectangular shape, thereby increasing the stability of the ship. The Coefficient of Prismatic (Cp) is the ratio between the volume of the hull below the surface of the water and the volume of a prism with the cross-sectional area of the midship area and the length of the ship. The Coefficient of Prismatic (Cp) value for the sample ship when it was empty was 0.612 and when it was fully loaded it was 0.48 at Wl 5. Based on the Cp value, the sample ship was found to have a widened body shape at the stern.

Purse Seine Ship Resistance

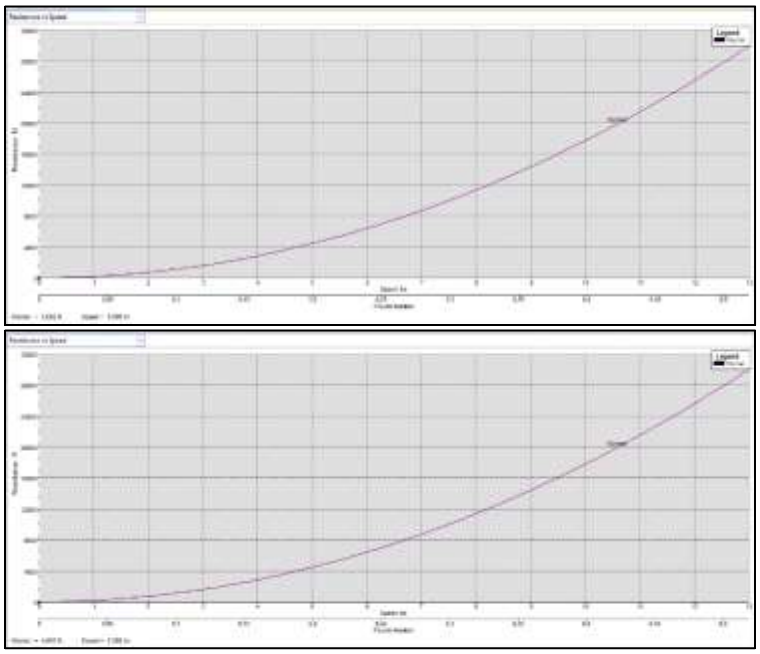
The hydrodynamics of traditional fishing vessels measuring 30 GT includes determining the main dimensions of the vessel, the resistance and strength of the vessel, the stability and maneuverability of the vessel have been studied (Muhammad et al., 2015). Ship resistance values and estimated power have been generated using the Wyman method, while ship stability and maneuverability have been assessed based on IMO criteria. The detailed results of the calculation (running) using the maxsurft resistance software obtained the calculation of the resistance of the purse seine vessels both before and after the redesign with empty and full load conditions as follows:

Table 9 Results Of Ship Running Resistance

Speed (Kn)	Before redesign		After redesign	
	Empty payload (N)	Full charge (N)	Empty payload (N)	Full charge (N)
0	--	--	--	--
0,325	18,77	27,7	18,77	27,7
0,65	75,07	110,8	75,07	110,8
0,975	168,9	249,3	168,9	249,3
1,3	300,27	443,2	300,27	443,2
1,625	469,17	692,5	469,17	692,5
1,95	675,6	997,2	675,6	997,2
2,275	919,57	1357,29	919,57	1357,29
2,6	1201,07	1772,79	1201,07	1772,79
2,925	1520,11	2243,69	1520,11	2243,69
3,25	1876,68	2769,99	1876,68	2769,99
3,575	2270,78	3351,69	2270,78	3351,69
3,9	2702,42	3988,78	2702,42	3988,78
4,225	3171,59	4681,28	3171,59	4681,28
4,55	3678,29	5429,18	3678,29	5429,18
4,875	4222,53	6232,48	4222,53	6232,48
5,2	4804,3	7091,17	4804,3	7091,17
5,525	5423,6	8005,27	5423,6	8005,27
5,85	6080,44	8974,77	6080,44	8974,77
6,175	6774,81	9999,66	6774,81	9999,66
6,5	7506,72	11079,96	7506,72	11079,96
6,825	8276,16	12215,65	8276,16	12215,65
7,15	9083,13	13406,75	9083,13	13406,75
7,475	9927,63	14653,24	9927,63	14653,24
7,8	10809,67	15955,14	10809,67	15955,14

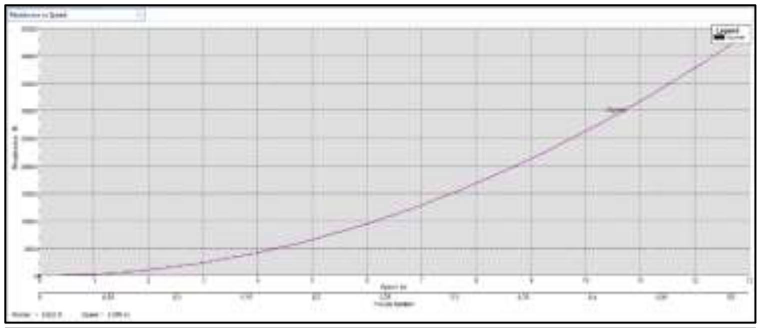
8,125	11729,25	17312,43	11729,25	17312,43
8,45	12686,35	18725,13	12686,35	18725,13
8,775	13680,99	20193,22	13680,99	20193,22
9,1	14713,17	21716,72	14713,17	21716,72
9,425	15782,87	23295,61	15782,87	23295,61
9,75	16890,11	24929,9	16890,11	24929,91
10,075	18034,89	26619,6	18034,89	26619,6
10,4	19217,2	28364,69	19217,2	28364,69
10,725	20437,04	30165,18	20437,04	30165,19
11,05	21694,41	32021,08	21694,41	32021,08
11,375	22989,32	33932,37	22989,32	33932,37
11,7	24321,76	35899,06	24321,76	35899,06
12,025	25691,74	37921,15	25691,74	37921,16
12,35	27099,25	39998,65	27099,25	39998,65
12,675	28544,29	42131,54	28544,29	42131,54
13	30026,87	44319,83	30026,87	44319,83

Next (Table 9) compares the shape of the waves that occur due to obstacles on the ship. The division is based on the ship's service speed, these results are complemented by the curve image below (Figure 3).



3A

3B



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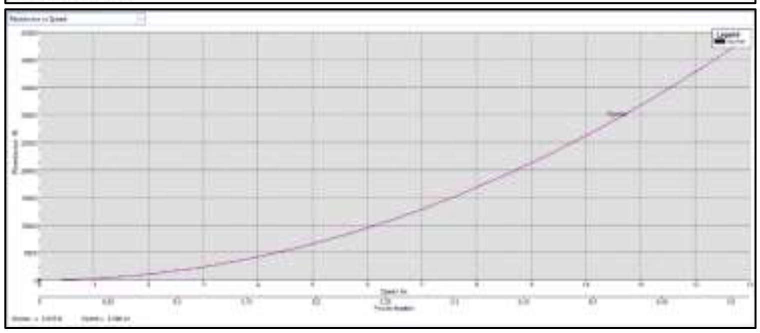


3D

Figure 3 Ship resistance running yield curve before (3A), after redesign (3B) empty load condition and before (3C), after redesign (3D) full load condition

The calculation of the ship's total resistance on Maxsurf Resistance is carried out by specifying the relevant calculation method. In this study using the Wyman method. The use of this method is due to considering the type of vessel that is in accordance with the method used, namely the type of fishing vessel. Running ship resistance using a wyman also supports research with V-shaped fishing boat hulls. The V-shaped hull has a large displacement value used to defend water at high speeds so as to minimize wavy water resistance. The service speed of fishing vessels in the Sinjai Regency area is planned to be 13 knots.

The results of the ship's Wyman running resistance before and after the redesign at a speed of 13 knots show the value of the ship's resistance before redesigning the empty load is 30026.87 N while the full load is 44319.83 N, has the same value after the redesign the empty load is 30026.87 N while the full load is worth 44319.83 N. as shown in the result graph as shown in (Figure 5). For the results of the redesigned and pre-redesigned purse seine resistance curves, there were no significant changes in the pre- and post-redesigned vessel curves. It can be explained that there is an increase in resistance as speed increases. The greater the speed applied, the greater the resistance obtained. The resistance value issued by the Wyman method is presented in Newton units (N), while the existing velocity is presented in Knots (Kn). From the pictures before and after the redesign we can see that there is no significant increase in resistance in the 13 Knots speed range. Any increase in speed entered will be directly proportional to the amount of resistance generated. If the increase in speed continues to increase, the value of resistance will also increase according to the pattern of the linear quadratic line equation.

According to (Lee et al., 2021), the trend in the results of the analysis of adding prisoners varies according to the type of ship. The potential method yields relatively accurate results for blunt boats at low speeds; however, they show some limitations in their tight predictions for lean bodies at high speed. Appropriate choice of analytical technique suitable for particular hull shape and forward velocity conditions is required considering its efficiency, accuracy and limitations for prediction of incremental resistance.

Reducing Fuel for Purse Seine Ships

Furthermore, the calculation (running) power using maxsurft resistance software for purse seine ships both before and after redesign with empty and full load conditions shows the following results:

Table 10 Results of the ship's running power

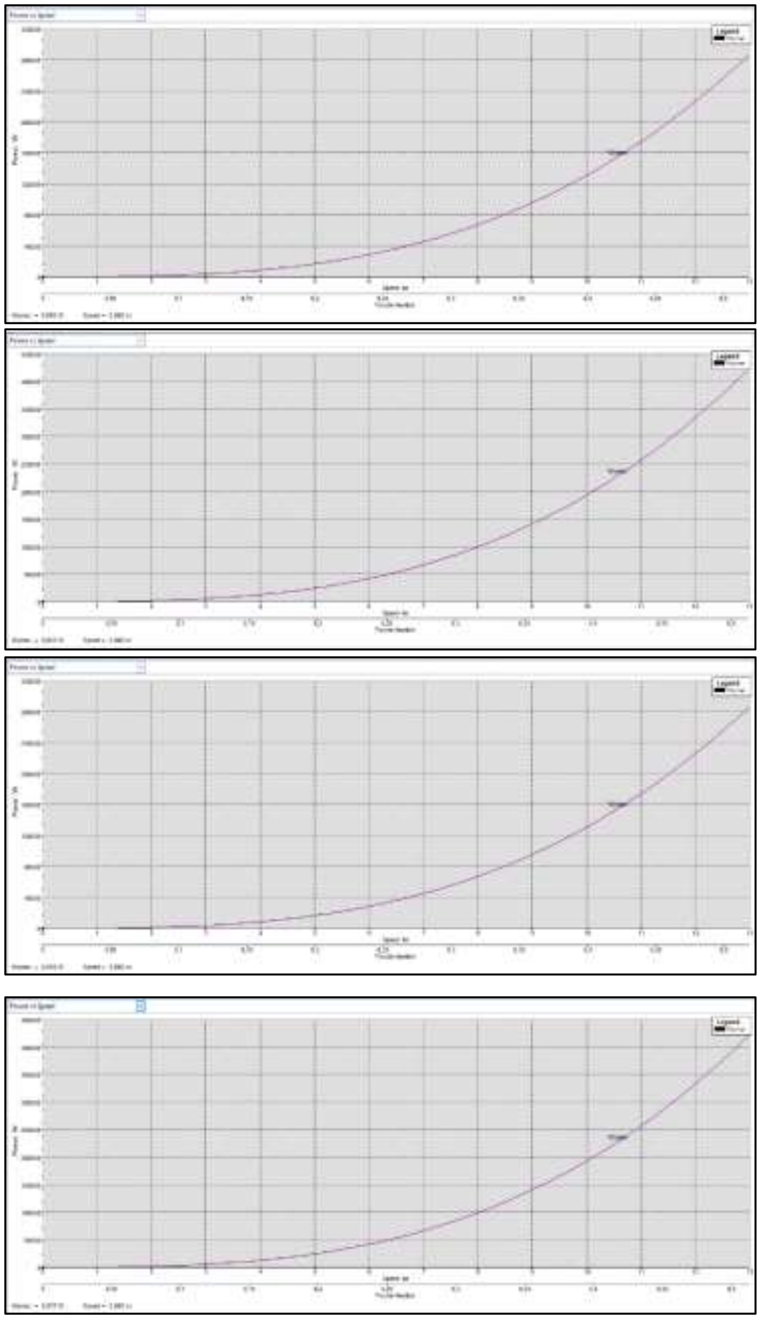
Speed **(Kn)**	**Before Redesign**		**After Redesign**	
	Empty Load (W)	**Full load (W)**	**Empty load (W)**	**Full load (W)**
0	--	--	--	--
0,325	4,48	6,62	4,48	6,62
0,65	35,86	52,93	35,86	52,93

0,975	121,03	178,63	121,03	178,63
1,3	286,88	423,43	286,88	423,43
1,625	560,3	827,01	560,3	827,01
1,95	968,21	1429,08	968,21	1429,08
2,275	1537,47	2269,32	1537,47	2269,32
2,6	2295,01	3387,44	2295,01	3387,44
2,925	3267,69	4823,14	3267,69	4823,14
3,25	4482,43	6616,1	4482,43	6616,1
3,575	5966,12	8806,03	5966,12	8806,03
3,9	7745,65	11432,62	7745,65	11432,62
4,225	9847,91	14535,57	9847,91	14535,57
4,55	12299,8	18154,57	12299,8	18154,57
4,875	15128,21	22329,33	15128,21	22329,33
5,2	18360,05	27099,54	18360,05	27099,54
5,525	22022,2	32504,89	22022,2	32504,89
5,85	26141,55	38585,08	26141,55	38585,09
6,175	30745,01	45379,81	30745,01	45379,82
6,5	35859,47	52928,78	35859,47	52928,79
6,825	41511,82	61271,68	41511,82	61271,69
7,15	47728,95	70448,21	47728,95	70448,21
7,475	54537,77	80498,06	54537,77	80498,07
7,8	61965,16	91460,93	61965,16	91460,94
8,125	70038,02	103376,53	70038,02	103376,54
8,45	78783,25	116284,53	78783,25	116284,54
8,775	88227,74	130224,65	88227,74	130224,66
9,1	98398,38	145236,58	98398,38	145236,59
9,425	109322,07	161360,01	109322,07	161360,02
9,75	121025,7	178634,64	121025,7	178634,65
10,075	133536,18	197100,16	133536,18	197100,18
10,4	146880,38	216796,29	146880,38	216796,31
10,725	161085,21	237762,7	161085,21	237762,72
11,05	176177,57	260039,1	176177,57	260039,13
11,375	192184,34	283665,19	192184,34	283665,21
11,7	209132,42	308680,65	209132,42	308680,68
12,025	227048,7	335125,19	227048,7	335125,23
12,35	245960,09	363038,51	245960,09	363038,55
12,675	265893,47	392460,3	265893,47	392460,33

***Speed* (Kn)**	**Before redesign**		**After redesign**	
	Empty payload (W)	**Full charge (W)**	**Empty payload (W)**	**Full charge (W)**
0	--	--	--	--
0,325	4,48	6,62	4,48	6,62
0,65	35,86	52,93	35,86	52,93
0,975	121,03	178,63	121,03	178,63
1,3	286,88	423,43	286,88	423,43
1,625	560,3	827,01	560,3	827,01
1,95	968,21	1429,08	968,21	1429,08
2,275	1537,47	2269,32	1537,47	2269,32
2,6	2295,01	3387,44	2295,01	3387,44
2,925	3267,69	4823,14	3267,69	4823,14
3,25	4482,43	6616,1	4482,43	6616,1
3,575	5966,12	8806,03	5966,12	8806,03
3,9	7745,65	11432,62	7745,65	11432,62
4,225	9847,91	14535,57	9847,91	14535,57
4,55	12299,8	18154,57	12299,8	18154,57
4,875	15128,21	22329,33	15128,21	22329,33
5,2	18360,05	27099,54	18360,05	27099,54

5,525	22022,2	32504,89	22022,2	32504,89
5,85	26141,55	38585,08	26141,55	38585,09
6,175	30745,01	45379,81	30745,01	45379,82
6,5	35859,47	52928,78	35859,47	52928,79
6,825	41511,82	61271,68	41511,82	61271,69
7,15	47728,95	70448,21	47728,95	70448,21
7,475	54537,77	80498,06	54537,77	80498,07
7,8	61965,16	91460,93	61965,16	91460,94
8,125	70038,02	103376,53	70038,02	103376,54
8,45	78783,25	116284,53	78783,25	116284,54
8,775	88227,74	130224,65	88227,74	130224,66
9,1	98398,38	145236,58	98398,38	145236,59
9,425	109322,07	161360,01	109322,07	161360,02
9,75	121025,7	178634,64	121025,7	178634,65
10,075	133536,18	197100,16	133536,18	197100,18
10,4	146880,38	216796,29	146880,38	216796,31
10,725	161085,21	237762,7	161085,21	237762,72
11,05	176177,57	260039,1	176177,57	260039,13
11,375	192184,34	283665,19	192184,34	283665,21
11,7	209132,42	308680,65	209132,42	308680,68
12,025	227048,7	335125,19	227048,7	335125,23
12,35	245960,09	363038,51	245960,09	363038,55
12,675	265893,47	392460,3	265893,47	392460,33
13	286875,74	423430,25	286875,74	423430,29

The results (Table 10) are complemented by an image of the curve of the *running power* yield curve using *maxsurf resistance* as shown below, (Figure 4).



4A

4B

4C

4D

Figure 4 Ship running power result curve before (2A) after (2B) redesign of empty load conditions and before (2C) after (2D) redesign of full load conditions

For the results of the fuel reduction curve for purse seine ships that have been redesigned and before the redesign did not experience significant changes, sample ships with speeds of 0-13 Knots using the wyman method with units of Watts (W) produced power for the value before redesigning empty cargo 286875.74 W while a full charge is worth 423430.25 W, the same as after redesigning an empty charge of 286875.74 W while a full charge is worth 423430.29 W. Then after the speed continues to increase, the power value follows an increase with a quadratic linear equation pattern.

From the results of the analysis of the decrease in fuel produced at 0-13 knots before and after the redesign, there was no significant change in value, meaning that there was no change in the decrease in fuel that occurred in the redesign of the ship, except for empty and full load conditions. so that this needs to be considered in terms of reducing exhaust gas can be minimized by redesigning fishing vessels so that they comply with predetermined standards, where the reduction in ship resistance and has implications for reducing fuel consumption. This was revealed in the results of the study, the small engine power will save fuel use and thus will affect the addition of the ship's load capacity (fish hold) (Hutauruk, 2013).

Predicting the increase in power at sea is actually very important for estimating fuel consumption, and for finding optimal sea routes for cooperation. Sea waves are characterized by irregular short waves with various frequency and direction distributions, as well as relevant ship responses (Yu et al., 2022). A ship's speed is expressed in knots which is equal to one nautical mile per hour. The unit for engine power is expressed in horse power (HP) which is equal to 75 kg m/s or equal to 4500 kg m/min (Fyson, 1995). The ship propulsion system in the form of a propeller is related to the rotation of the shaft produced on the main engine which only rotates in one direction (clockwise) or counterclockwise. The main engine or commonly called the main engine on the ship is an important part of the ship which includes internal combustion engines. In an internal combustion engine, the fuel is burned directly in the cylinder under pressure from the fuel combustion gases. The importance of selecting an engine for a ship based on actual sea conditions. In addition, a comparison for the short time operation of the ship is presented, which reconfirms the resulting effectiveness of the suggested optimization process (Esmailian & Steen, 2022).

In recent years, the sea transportation business has developed rapidly. This development has brought about many environmental pollution problems, including pollution from berthing ships. When the ship is anchored, the auxiliary motor on board is still working to meet essential power needs. noise and a lot of harmful gases will be generated. This will cause pollution to the surrounding environment (Zhu et al., 2022). ITS Siskala Lecturer Dr. Eddy Setyo Koenhardono ST MSc., revealed that there are various kinds of mustiness that can be optimized in order to reduce ship gas emissions. Starting from optimizing the shape of the hull, choosing alternative fuels and energy, or aligning the weather and routes. There is a solution that is not optimal besides the previous option, namely optimizing the propulsion/propulsion system on the ship. By optimizing the use of fuel on board, it can result in reduced fuel consumption and exhaust emissions, such as CO (Carbon Monoxide), NOX (Nitrogen Oxides) and SOX (Sulfur Oxides) which can pollute the environment. One of the most important projects is to achieve the global carbon dioxide reduction target (Zhao et al., 2022).

Comparison of Ships Before Redesign and After Redesign

So, the comparison before and after the redesign of the three samples did not change either in hydrostatic, resistance and power values, which were different when the load was empty and full and KGm for each sample ship due to the transfer of the hatch below the ship's deck. However, for samples after the redesign it was better because the hatch above the deck which took up part of the area above the deck had been moved down to fill the void below the deck and provided a large space above the deck so that the crew members could freely carry out their duties during fishing operations and also allows the resulting stability value to be better than the ship before the redesign. There are no related changes because there is no redesign of the hull or bow and ship size according to the statement (Wendi et al., 2015). With this hull keel design, resistance and the movement of the ship can be reduced.

Conclusion

Based on the research results obtained, it can be concluded that the redesign of the purse seine ship was carried out only by moving the hold space above the ship's deck to below the ship's deck without changing the main size, shape of the stern, bow and hull in accordance with the local wisdom of the ship. The hydrostatic quantity obtained from the purse seine after the redesign has the same value as the hydrostatic quantity of the ship before the redesign, it's just that there is a different hydrostatic value such as KGm. The hydrostatic quantity affects the sample ship after the redesign because it has a small KGm value due to the fact that the hold has been moved below the deck so that it is said to be better than before the redesign. The resistance obtained at a speed of 0-13 knots after redesigning the purse seine does not experience a significant change compared to the resistance on the ship before the redesign except in conditions of empty cargo, so the greater the speed and weight of the ship (cargo), the resulting value of the ship's resistance will be higher. The decrease in fuel produced at a speed of 0-13 knots for purse seine ships after redesign has not changed significantly with a change of 0.3 W - 0.4 W from the value of the ship before redesign, but has a big difference in the value of power in an empty condition with the value of power, so the higher the speed and weight of the ship (cargo), the power needed also increases.

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