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Evaluation of Radar Reflector Design forTraditional Fishermen in Banyuwangi

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Abstract: Every fishing boat owned by fishermen in the Muncar Harbor area of Banyuwangi is always decorated. In addition to beautifying the ship, they also provide enthusiasm for work. Various decorations used include the shape of the dome of the mosque and the shape of a butterfly. Although technically all ornaments do not support their safety at sea. Accidents, namely the collision of traditional fishing vessels by large commercial vessels often occur. because the area of operation of traditional fishermen is the trajectory of large commercial ships. Many accidents occur because the presence of fishing boats is not detected by commercial vessels. because most traditional fishing boats are made of materials that do not reflect the radar signals of large vessels. For this reason, it is very necessary to install a reflector radar, which is a passive radar that serves to increase the object's Radar Cross Section value. This radar can be mounted on fishing vessels so that the reflected energy from this radar reflector can be recognized by large ships. This article describes designs that are in demand by traditional fishermen in the Muncar area of Banyuwangi.

Keywords: Fisherman, Radar Cross Section, Radar, RadarReflector, ornament

INTRODUCTION

Data from KIARA (Koalisi Rakyat untuk Fisheries Justice- People's Coalition for Fisheries Justice) shows that the number of fatal accidents that cause death is very high in the national fisheries sector. Based on KIARA data, the number of victims who died from 2012, 2013 to 2014 were 186,225 and 210 people, respectively. The main problem in the capture fisheries sector in Indonesia is about K3 (Occupational Health and Safety) on ships. There are even some people who think that safety is not important, the important thing is that the catch is quite a lot. This assumption is the background for holding marine safety socialization activities to fishermen, to provide understanding to traditional fishermen to care about safety at sea (Knott, et al., 1985).

The forms of work accidents that quite often occur in the national fisheries sector are fishing boats being hit by a much larger steel ship, such as barges or cargo as happened in 2019, when a fishing boat was hit by container ship in the waters of Masalembu, Madura. Twelve (12) fishermen crews were rescued by the Tug Boat which was passing through the waters around the scene. The main cause of collision of traditional fishing boats with large ships is because the radar of large ships is not able to detect the presence of traditional fishing boats. Traditional fishing boats are made of materials that are

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not good at reflecting the radar signals emitted by large ships. Especially if the conditions at night. The lack of navigation lights on traditional fishing vessels is also another cause of collisions between fishing vessels and commercial vessels. Where the safety requirements of sailing fishing vessels are not met, including the use of lights and navigational equipment.

Lamp Navigation is one of the navigation safety tools and this equipment is rarely found in traditional fishing boats in the Brondong and Muncar areas, two big communities of fishermen in East Java who generally operate in the northern sea of the island of Java and in the Bali Strait (Wibawa, et al, 2020). These waters are often traversed by merchant ships, ferries and ships barges carrying coal which are at risk of accidents with ships; traditional fishing boat. The use of navigation lights on fishing vessels is absolutely necessary to signaling to large ships of the presence of fishing vessels, and the type of fishing gear used in FAO recommendations, namely on Safety Recommendations for Fishing Vessels with a Deck Length of Less than 12 Meters and Fishing Boat Without Deck, Navigation Equipment That Must Also Be Installed on fishing vessels is a radar reflector. The radar reflector is used to reflect returns radar waves from large ships.

Fishing boats are mostly made of non-metallic materials such as wooden boats and Fiberglass Reinforced Plastic (FRP). This is what causes the presence of small ships to go undetected. The installation of Radar Reflectors is expected to cause fishing boats to be detected by large ships. The installation of radar reflector can be seen in Figure 1.

Figure 1. Placement of the radar reflector on the mast

International Maritime Organization (IMO) in ANNEX 28, RESOLUTION MSC.164(78) on "REVISED PERFORMANCE STANDARDS FOR RADAR REFLECTORS" determined as follows:

1) All ships must be equipped with radar reflectors, so that they can be detected by ships navigating with radar in the 9 GHz and 3 GHz bands
2) Mounting arrangements shall be provided on board so that the reflector can mounted either on a rigid stand or on a rope system ship installation.
3) For small ships, the maximum weight of the radar reflector to be installed in 4 m high is 5 kg. The reflectoris designed to be mounted on the greater height must have a calculated weight equal to, or less than 4 m/5kg.
4) The physical size of the radar reflector should be mini- mized and should not exceed 0.05 m3.

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Radar Reflector Design

A. Radar Cross section

When the radar signal is reflected from irregular objects such as buoys, sailboats, fish boats etc., the signal will return in all directions and only a small part of it is likely to reach the target. The term Radar Cross section is the part of the area that bounces back to the target (Yim and Kim, 2003). In general, maritime radar is divided into 2 bands, namely X-band and S-band. In accordance with the rules that large ships must have at least an X-band radar and even some types of ships are required to have both. X-band radar operates in the 9.4 GHz frequency with a wavelength of about 3.2 cm. while the S-band radar operates at a frequency of 3.0 GHz with a wavelength of 10.0 cm. X band has more resolution and better detection than S-band radar. Although the S-band radar is not good at detecting smaller objects, the S-band radar is less susceptible to interference with rain and ocean disturbances. S-band radar has a longer range than X-band radar

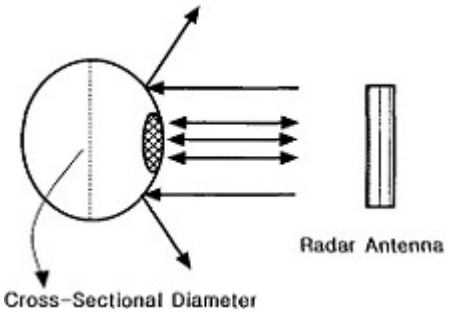

Figure 2. Indicate RCS

B. Analysis RCS

Radar reflectors are an effective device for avoiding collisions between traditional fishing vessels and commercial vessels. The shape of the radar reflector is very simple, namely a triangle, circle, and rectangle. Figure 3 shows the standard and simple shape of a common radar reflector.

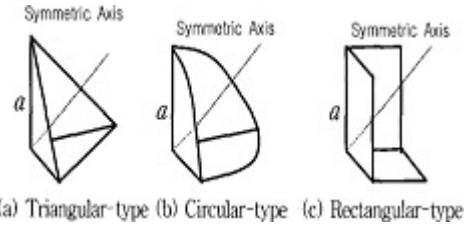

Figure 3. Radar Reflector Type (Yim and Kim, 2003)

From the two equations, namely the maximum RCS value (sigma max) and the maximum distance that can be detectedby radar, it can be summarized for the three equations assummarized in table 1.

Table 1. The value of σmax and Rmax

No	Configuration	RCS max, σmax	Range Radar max
1	Triangular Tri-hederal	1.0	1.0
2	Circular Tri-hederal	3.7	1.4

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3	Rectangular tri-hederal	8.9	1.7

Table 1. Shows that RCS value increases significantly from the triangular-type to the circular-type and rectangular-type. However, in term of range, the increases are small.

The Local Wisdom Design Type Radar Reflector

The results of the Focus of Discussion Group (FGD) with fishing communities in the Muncar area, also show that fishingboats in the Muncar area are not yet equipped with equipment. Adequate safety on board the ship, including the use of reflector radar. This is more due to the ignorance of local fishermen about the functions and benefits of radar reflector for shipping safety (Wibawa, 2018). Presentation on radar reflectors along with some examples of radar prototypes reflector to fishermen, providing sufficient understanding to fishermen.

Results the discussion shows that Muncar fishermen are very interested in using a radar reflector (RR) on their fishing boats. All FGD participants stated interest in using radar reflectors on their fishing boats, especially because the waters of the Bali strait include shipping lanes that are relatively busy with large ships passing by. Observations on local fishing boats in Muncar and discussions with fishermen of the local area also shows that aesthetic factors are an integral part of inseparable from the practice of capture fisheries in the Muncar area, Banyuwangi. Beside associated with personal and group pride of fishermen, decoration on fishing boats related to the Picking Laut tradition which is a way for local fishermen to express gratitude for the seafood they have obtained for one year. With these considerations, Muncar fishermen pay very close attention to the ornaments they wear that will be installed on their fishing boats. This can also be seen from the choice of FGD participants to alternative designs of radar reflectors that are suitable for their ships. As can be seen in the Pie Chart in Figure 4. Fishermen tend to choose shapes that are based on the ornaments that are often found on local fishing boats, namely the design butterfly-shaped and dome-shaped design that is commonly found on fishing boats in Muncar area.

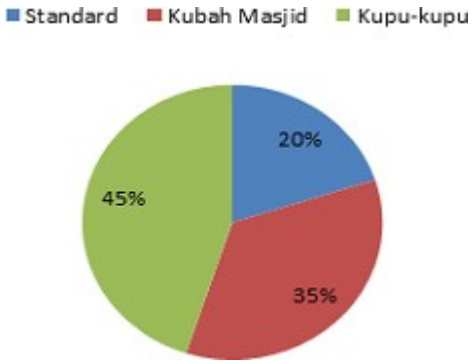

Figure 4. RR Local Wisdom Type

In addition to the design of an alternative radar reflector that is tailored to the design ornaments that are often found on local traditional fishing boats, the technical aspects of the radar reflector designed for the Muncar fishing boat has also been adapted to recommendation from The Maritime Safety Committee in ANNEX 28, RESOLUTION MSC.164(78). Especially regarding the mounting height on the ship, volume and weight from the radar reflector. The average Mast height for fishing boats in Muncar is a minimum of 5 meters, so that the installation height of the radar reflector is in accordance with high standards minimum. While the maximum allowable weight is 5kg with a volume maximum is 0.05 m^3.

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Weight and volume design results on alternative radar the reflector proposed to Muncar fishermen can be seen in table 2.

Table 2. Volume and Heavy Radar Reflector Type

No	Radar Reflector Design	Volume	Heavy	FAO Recommendation
1.	FAO Standard	0.027	1.512	Macth
2.	Butterfly Type	0.045	2.520	Macth
3.	Mosque Cube	0.032	2.451	Macth

RESULT AND DISCUSSION

The object RCS values of the various types of existing radar reflectors are calculated using the existing standard formulas. For the Radar reflector butterfly type using the triangular formula. For dome-type radar reflectors, use the circular formula. The size made is adjusted to the dimensions generally used by fishermen in decorating fishing boats, which is about 20 cm. Theoretically the RCS value for each type is calculated using the following formula:

$$\text{For butterfly-type: } \sigma_{max} = \frac{4\pi a^2}{3\lambda^2}$$

$$\text{For dome-type: } \sigma_{max} = \frac{16\pi a^2}{3\lambda^2}$$

Table 3 shows the results of calculating the RCS value as a function of frequency. It is known that the RCS value will increase along with the increase in frequency.

Table 3. Calculated RCS as Function of Frequency

No	Frequency (GHz)	RCS(m) for Butterfly	RCS(m) for Dome
1	3	8.38	31.23
2	9	75.42	280.98
3	10	93.11	346.89
4	11	112.66	419.74
5	12	134.08	499.52

This means that fishing vessels will increasingly be detected by large commercial vessels if they use the X-Band radar frequency. Based on the calculations in table 3, it is also known that the RCS value of the dome-shaped radar reflector is better than the butterfly- shaped reflector radar.

CONCLUSION

In the MSC resolution 164(78) document on the Performance standard for Radar Reflectors it is stated that the radar reflector should have a 'stated performance level' measured in square meters Radar Cross Section (m^2 RCS) of at least 7.5 m^2 in X-band and 0.5 m^2 in S-band mounted at minimum height of 4 m above water level. From table 3, the results of the RCS calculation for each type of radar reflector show that the butterfly-shaped S-band radar frequency has an RCS value of 8.38m. The X-band radar frequency has an RCS value of 75.42 m - 134.68 m. while for the S-band radar frequency the shape of

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the mosque dome has an RCS value of 31.23 m. The X-band radar frequency has an RCS value of 280.98 m - 499.52 m. meaning that both the shape of the butterfly and the shape of the dome have met the specified performance requirements.

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