Implementation of Safety Management System on Traditional Shipping for Strengthening the Blue Economy

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Abstract. Traditional Shipping 'Pelra' as part of the maritime transportation system is expected to support the concept of blue economy `in order to accelerate the national economy. *Pelra*, with all its limitations, is still the backbone of the maritime populist economy to support inter-island trade in Indonesia, especially the logistics distribution system services for the Disadvantaged, Outermost, Frontier, and Border Areas ("3TP")'. Traditional Shipping has not implemented a standardized Safety Management System (SMS) as in National shipping, so it often has accidents. The study analyzed the extent of the opportunity to apply SMS on *Pelra* ships by considering the characteristics of the water area (shipping lanes and wave conditions), as well as the incidence of accidents. It was found that the size of *Pelra* ships sailing in East Nusa Tenggara waters is dominated by vessels smaller than GT 100, making it possible to apply SMS. Factors that need to be considered in the implementation so that it is more effective are the resources and personnel (HR) factor, the responsibility and authority of the crew, and the responsibility and authority of authority of the company (Corp).

1 Introduction

The Blue Economy concept developed [1] focuses on innovation and creativity, based on the development of the people's economy, including the efficiency and effectiveness of the production system and the arrangement of the marine natural resource management system to increase economic growth with optimal utilization of sustainable marine natural resources. As in the Sustainable Development Goals (SDG's) agenda goal 14, namely the preservation and sustainable use of marine resources for development, especially in the maritime sector, improving the economy This concept is in accordance with the characteristics of the Indonesian archipelago as the Indonesian Maritime Continent (IMC), which has more than

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17,500 islands, 108 km of coastline, and three-quarters of the sea area. which consists of the majority of small islands classified as Small Island Development States (SIDS).

Indonesia, with potential marine resources in the fisheries, tourism, and maritime industry sectors, needs to strengthen the sea transportation system (shipping and port). Maritime ecosystems, which are the backbone of the national maritime economy, have not been developed to their fullest. In fact, the potential for empowering the maritime industry in the form of the shipyard industry, port operations, and the development of elements of the marine transportation system such as shipping and port fleets is still far from optimal as a major contributor to the national economic structure. Indonesia's maritime economic potential includes 11 sectors with an estimated value of around USD 1.33 trillion and employment opportunities for 45 million people, especially in the capture fisheries, aquaculture, and fish processing industries, tourism, environmental services, and maritime [2].

This is also in line with the vision of maritime development in the context of the maritime economy, namely increasing the role of the maritime economy from 6.4% in 2015 to 12.5% of GDP in 2045 with a focus on building efficient and effective sea connectivity, a sustainable and competitive fishing industry, and inclusive marine tourism. Similarly, maritime civilization and the power to create superior quality maritime human resources, maritime technology innovation, and strong maritime culture are the basis of maritime civilization in realizing a strong and reliable maritime security defense capability to face regional and global challenges.

1.1 Strategic Problems and Issues

In the national context, the blue economy has been stated in the RPJPN of 2005-2025, namely the realization of an advanced, resilient, and sovereign Indonesian archipelago through the implementation of sustainable development. In line with this, Indonesia, as a maritime country, has created the vision of the World Maritime Axis with development priorities through the development of a strong maritime civilization, a strong maritime power, and a rapidly growing maritime economy [3].

Synchronizing the blue economy concept with the 2045 world maritime axis, among others, is an effort to develop maritime infrastructure and connectivity. The strategy to realize the development of the maritime axis is carried out by increasing the role of the maritime economy to around 12.5% of Gross Domestic Product (GDP) in 2045, which focuses on (1) the development of efficient and effective sea connectivity, (2) the industrialization of fisheries production, and (3) inclusive marine tourism. The action plan is carried out by optimizing the role of sea transportation by improving the quality of services, including traditional shipping, from safety aspects in developing the archipelago through increasing commodity flows, product marketing intensity, and accessibility, supporting the maritime economy, tourism, and fisheries, and strengthening national resilience at the border.

One part of the sea transportation sector that is classified as a populist economic activity is the traditional Shipping ‘Pelra’ which plays an active role in serving the distribution of goods and the movement of people in local and national networks. Traditional shipping and sea transportation economic services are able to connect islands, especially in Disadvantaged, Outermost, Frontier, and Border areas (3TP) [4], [5]. The economy in the ‘3TP’ areas relies heavily on the flow of external consumer goods transported by *Pelra* [6]. As a result, the development of ‘3TP’ regions and growth centers is highly dependent on the accessibility of sea transportation, especially traditional shipping [7]. To achieve the maritime vision 2045, the government, with the vision of the World Maritime Axis, has again strengthened the maritime culture in all Indonesians.

The maritime economy is an economic activity that includes sea transportation, the shipyard industry, port operations, and related industries and services. The pillars of the maritime axis are the rebuilding of Indonesia's maritime culture, commitment to safeguarding and managing marine resources with a focus on building marine food sovereignty through the development of the fishing industry by placing fishermen as the main pillar, and commitment to encourage the development of maritime infrastructure and connectivity by building sea tolls, seaports, logistics, and industrial equipment, as well as maritime tourism.

Pelra is a sea transportation service with a capacity of up to 500 gross tons (GT) that is operated using traditional wooden ships, which have limited technical feasibility and operational distance [8], [9], as well as minimal adoption of class, insurance, and safety requirements. *Pelra's* operation in the '3TP' region is backbone transportation, as a feeder for Sea Toll transportation and conventional cargo ships [10]. *Pelra* is still believed to be a solution to increasing the effectiveness of domestic sea transportation, especially in island areas and areas where land mode facilities and infrastructure are inadequate [11]. On the other hand, the availability of national sea transportation is still very limited, so people still rely on traditional ships [12], [13]. Although the cost burden is relatively high for people in the islands and remote areas [14], *Pelra* is characterized by being able to serve areas with limited port infrastructure. *Pelra* is expected to be able to encourage economic growth in the '3TP' area and open up investment opportunities in order to increase the value of return cargo [15], [16].

In the period 2015-2020, there were 880 ship accidents in Indonesia, 57% of which were motorboats, and there were 81 traditional Shipping vessels that experienced accidents. The causes range from natural, technical, and human error factors. *Pelra* ship accidents predominantly occur in the seas of Eastern Indonesia. Pelra ship accidents in Indonesian waters are dominated by vessels of less than 150 GT, namely 82.95% [17] *Pelra* ship accident data for the 2015-2020 periods in Indonesian waters identified 19 casualties and material losses, and ecological damage has not been identified. Information from Basarnas East Nusa Tenggara Province explains that the number of *Pelra* ship accidents tends to increase, especially in 2015-2017 and 2018-2021.

Improving ship safety has become an international concern for the IMO, with the hope of "zero accidents." Therefore, international conventions on ship safety are enacted, including Solas 1974, Marpol 1973/1978, Load Line Convention 1966, Collreg 1972, Tannage Measurement 1966, STCW 1978 Amendment 85, ILO No. 147 1976, and ILO Convention No. 185 2008. In the implementation of these conventions, ratification has been carried out and derivative regulations have been made, including [18]–[20]. However, these rules have not been applied to *Pelra* ships, so they are believed to be one of the triggers for many accidents in Indonesia.

There is a gap between the expectations contained in international rules and conventions and the field conditions that trigger *Pelra* ship accidents in Indonesia, so it is necessary to find clarity on how to implement a safety management system on *Pelra* ships that have different characteristics from conventional ships. This research aims to analyze the opportunities for the application of SMS to *Pelra* ships. The output of this research is expected to be an input to further research in developing a safety management system policy strategy on *Pelra* ships.

2 Methodology

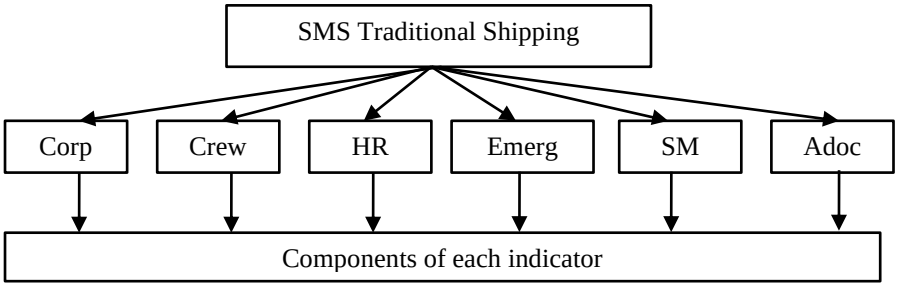
An assessment of the level of opportunity to implement a safety management system (SMS) on Pelra vessels was conducted on 138 vessels operating in East Nusa Tenggara (ENT) waters. Increasing the likelihood of SMS implementation will also increase Pelra's role in the maritime economy. This research used bivariate statistical analysis through the chi-square

test. The Chi-square test is used to compare the frequency of observation with the frequency of expectation. If the observed frequency value is the same as the expected frequency value, then it is said that there is no significant difference. Conversely, if the observed frequency value and the expected frequency value are different, then it is said that there is a significant difference. Proof with the chi-square test can use the formula:

$$X^2 = \sum \frac{(O-E)^2}{E} \qquad (1)$$

Where: O = observation value; E = expected value (expectation); df = degrees of freedom (b-1) (k-1); k = number of columns; b = number of rows.

It is said that there is a significant relationship between the two variables if the calculated chi-square (X2) value is> 38.4 in normal distribution data with a degree of confidence of 95%, and vice versa. Data were analyzed using SPSS version 25 based on the frequency of respondents' answers. The assessment is based on the mean/cut or cutoff of all respondents' answers (crew and ship owners). If the application of SMS on a ship is > mean, then the probability is considered "not good", but if the application is > mean, then the probability is considered "good". The assessment is carried out on the six factors described in Figure 1.



Description:
Corp = Company responsibility and authority
Crew = Crew responsibilities and authorities
HR = resources and personnel
Emerg = Emergency readiness
SM = Ship maintenance
Adoc = Administration and documentation

Fig. 1. Indicators for assessing the implementation of SMS *Pelra*

Secondary data used include *Pelra* ship accident data in ENT Province in the 2015-2021 period based on the type of incident, alleged causal factors, ship size, location of the incident (waters), number of casualties, and hydro-oceanographic data (waves), as well as literature searches from previous research and regulations related to the safety of Pelra vessels. Primary data in the form of information on the implementation of the safety system carried out by the crew and ship owner on 138 *Pelra* ships of varying sizes. The research analysis flow chart is shown in Figure 2.

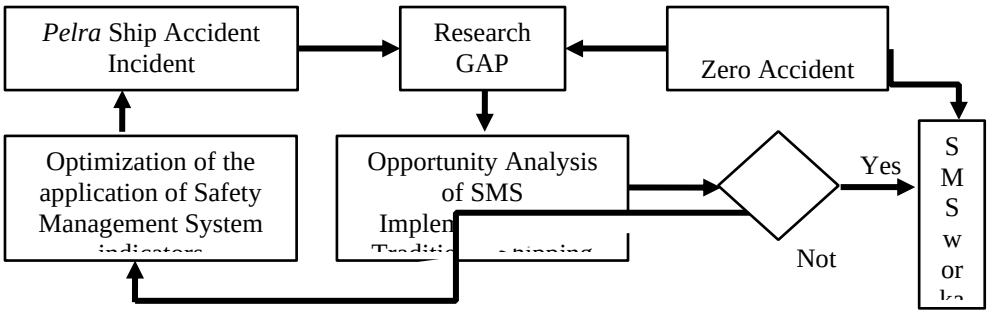


Fig. 2. Research Analysis Flow

3 Result and Discussion

3.1 Characteristics of Traditional Shipping Accidents

Traditional shipping ship accidents cause losses, both in the form of casualties and material losses. There were 18 cases of accidents in 2018, with 42 fatalities. In the 2015 and 2016 periods, there were 21 and 27 cases of fatalities of only 1 and 4 people. Details of the incidence of *Pelra* ship accidents and the number of casualties in East Nusa Tenggara (ENT) are shown in figures 3 and 4.

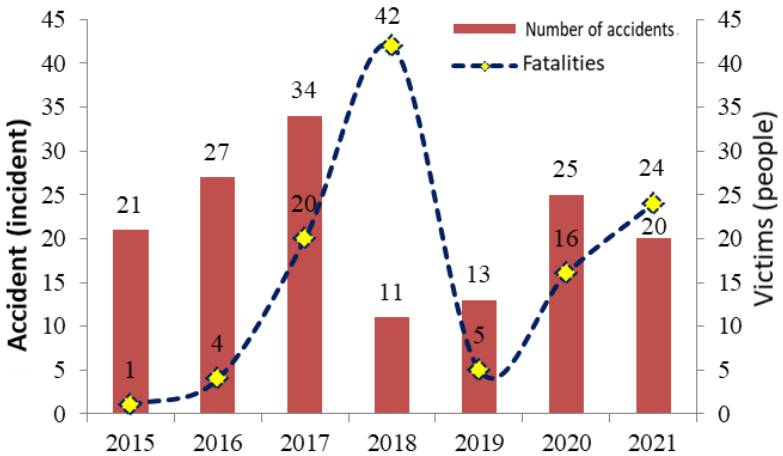


Fig. 3. *Pelra* ship accidents and casualties in East Nusa Tenggara

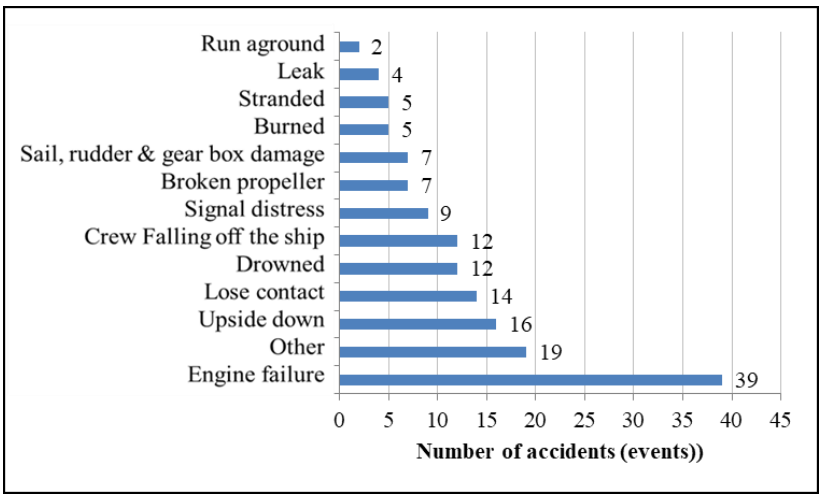


Fig. 4. Types of *Pelra* ship accidents and indication of causes

3.2 Oceanographic Conditions in the Waters of East Nusa Tenggara

There are 22% of *Pelra* accidents in East Nusa Tenggara that are caused by environmental factors, namely wind and high waves. GT 10-500 ship sizes have difficulty sailing when weather conditions are extreme. Information on oceanographic conditions and the crew's ability to predict water conditions is very important. The results of the identification of wind and wave characteristics in East Nusa Tenggara Waters were carried out at four locations (Figure 5). Wind data based on predictions issued by the European Center for Middle-range Weather Forcasting (ECMWF) which can be accessed online through: https://cds.climate.copernicus.eu.

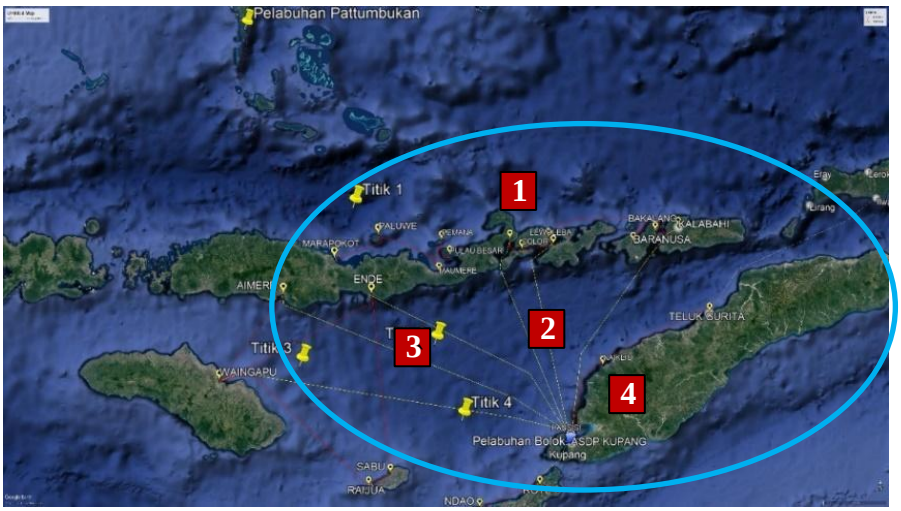


Fig. 5. Location of oceanographic data collection in East Nusa Tenggara Waters

The dominant percentage of wind events in the 2.5 m/s - 4.5 m/s speed interval occurred at locations 1, 2, and 4, with a percentage of events of 42.86%, 29.00%, and 29.30%, respectively. The wind speed interval of 4.5 m/s - 6.5 m/s occurred at location 4, with a percentage of occurrences of 29.30%. Wave characteristics are dominated by wave heights

of 2.0 m - 3.9 m, with a percentage of wave height of 51.23%. Furthermore, waves with an interval of 1.5 m - 2.0 m occurred at locations 2, 3, and 4 with a percentage of 48.12%, 42.49%, and 52.84%, respectively. The shape of the wave is shown in Figure 6.

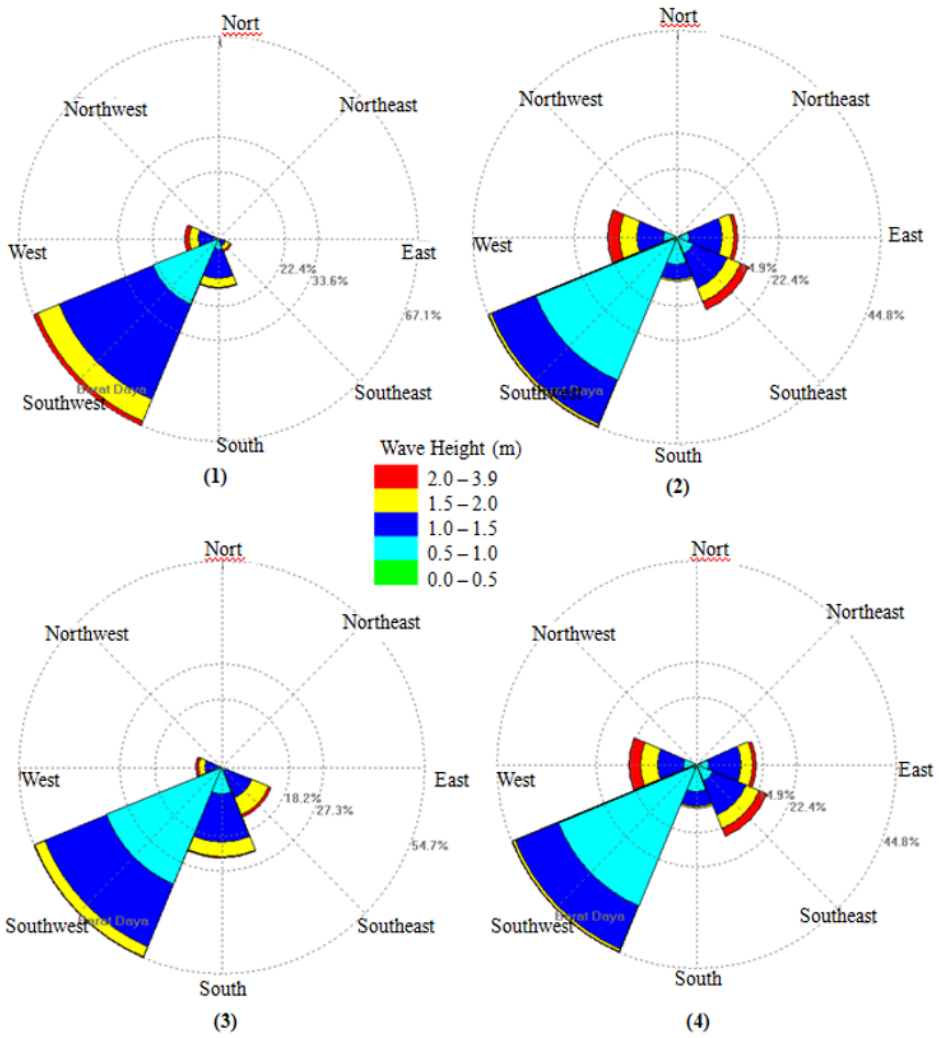


Fig. 6. Wave Roses in East Nusa Tenggara Waters

3.3 Opportunities for Safety Management System Implementation on *Pelra* Ships

Based on SMS indicators and a sample vessel size between 10 - 500 GT, 138 vessels The results of the analysis show that most *Pelra* ships allow SMS to be implemented properly. Based on the indicators or facts of corporate responsibility and authority (Corp), 102 vessels (73.9%), the factor of "crew responsibility and authority", 94 ships (68.1%), the factor of "resources and personnel" (HR), 86 vessels (62.3%), the factor of "emergency preparedness" (Emerg), 115 vessels (83.3%), the factor of "ship maintenance" (SM), 118 ships (85.5%), and the factor of "administration and documents" (AD), 116 vessels (84.1%) are likely to

implement SMS well. A detailed comparison of the probability of SMS implementation for each factor is shown in Figure 7.

In addition to assessing the opportunities for SMS implementation based on the indicators, an assessment of vessel size was also conducted using crosstab analysis. This analysis will show how ship size relates to the opportunity to implement SMS *Pelra*. Details of ship size are categorized as follows: 1). Category A vessels with GT <100 = 66.7% or 92 vessels, GT 101-200 = 15.2% or 21 vessels, GT 201-300 = 8.0% or 11 vessels, GT 301-400 = 3.6% or 5 ships; and GT 401-500 = 6.5% or 9 ships.

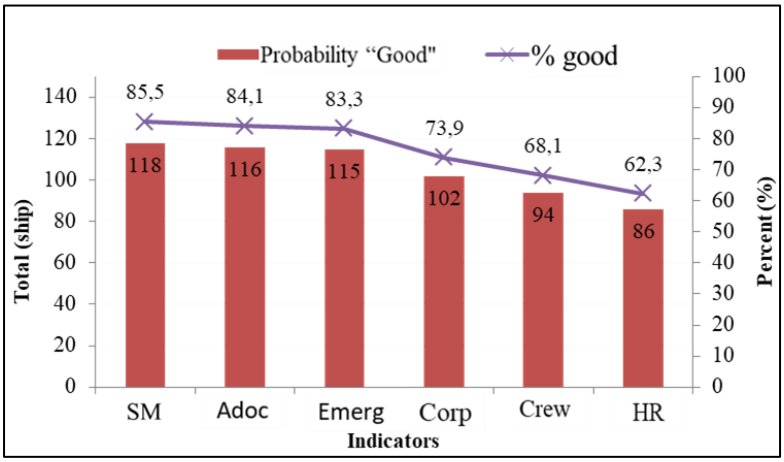


Fig. 7. Comparison Chart of Probability of SMS Implementation

The analysis shows that Pelra vessels of less than 100 GT dominate shipping in East Nusa Tenggara Waters by as much as 66%. With the characteristics of high wave waters, the possibility of having an accident will increase. Based on the size of the ship, the opportunity to apply for SMS for vessels less than 100 GT with a poor category is 22.5% and a good category is 77.5%. Vessel size 101-200 GT, with a poor category of 20.6% and a good category of 79.4%.

Ship sizes 201-300 GT have a poor category of 18.2% and a good category of 81.8%. Ship sizes 301-400 GT have a poor category of 13.3% and a good category of 68.7%. Ship sizes 401-500 GT have a poor category of 20.4% and a good category of 79.6%. More complete information is in Table 1 and Figure 8.

Table 1. Implementation opportunities of SMS for *Pelra* ships based on ship size.

Factors / variables		Corp	Crew	HR	Adoc	SM	Emerg	Average
Assessment of the Probability of Implementation		Good	Good	Good	Good	Good	Good	%
Ship Size (GT)	<100 (A)	64	57	53	74	73	77	65.4
	101-200 (B)	19	16	12	21	13	17	15.3
	201-300 (C)	8	10	10	11	6	9	8.3
	301-400 (D)	5	4	3	5	3	4	4.0
	401-500 (E)	6	7	8	8	6	8	6.6

Total	102	94	86	116	118	115	
Percent	73.9%	68.1%	62.3 %	84.1%	85.5%	85.5%	78.6

Source: Analysis result, 2023

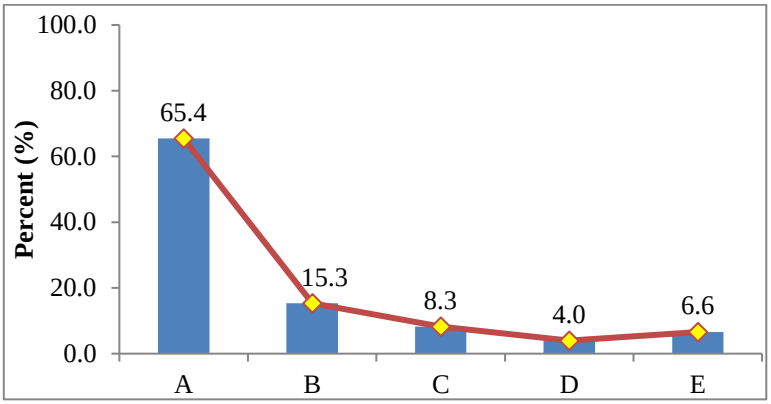


Fig. 8. Percentage of opportunities to implement SMS *Pelra* ships by vessel size

4 Conclusions

The implementation of the traditional shipping 'Pelra' sea transportation SMS is part of increasing the role of Pelra in Indonesia's maritime sector. The characteristics of traditional shipping, which are still traditional in nature, make it vulnerable to the safety aspects of the ship. Even though its role is very strategic in the distribution of goods in eastern Indonesia. The size of ships sailing in East Nusa Tenggara waters is mostly GT <100 at 66.6%, so the tendency of ships to have accidents is also small. In the 2015-2021 period, the main cause of accidents was technical factors (44%), followed by human factors (34%), and the environment (22%). Wave characteristics in East Nusa Tenggara waters tend to be high and very risky for the safety of GT<100 ships.

Of the six factors reviewed, the opportunity to implement a safety management system (SMS) is possible for Pelra vessels. Potentially unfavorable factors in the implementation of SMS are resources and personnel (HR) at 37.7%, crew responsibility and authority at 31.9%, and company responsibility and authority (Corp) at 26.1%. When viewed from the size of the ship, the probability of SMS implementation is considered poor, namely ships of GT size <100 at 22.5%, followed by vessels of GT size 101-200 at 20.6%, and vessels of GT size 401-500 at 20.4%. However, there is no significant influence between ship size and the probability of good or bad implementation of SMS on Pelra vessels. From the findings of this study, the magnitude of the influence of each variable on the application of SMS will be analyzed, which will later be used as a policy strategy for implementing SMS on *Pelra* ships.

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