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Organization as the Cause of Ship Collision in Indonesian Waters

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***Abstract*— Ships have an important role in increasing world trade. The increase in the shipping industry has an impact on the marine transportation. The increase of the marine transportation is not in line with marine safety. There are risks when the ship on a voyage. One of them is a ship collision. Ship accidents will result in losses, such as casualties, injuries and material loss, and loss of life. International Maritime Organization (IMO) issues a collision regulation to prevent ship collisions. However, it does not develop marine safety. Based on data from Coastal Guard, there are 46 ship collisions in Indonesian water in 2010 to 2017. The research analyze organization factor in the ship collisions uses HOR phase 1 method. Root causes of ship collision in this research is shipping company does not carry out the crew recruitment process properly and do not have a program to increase the crew competence, maritime education does not carry out the educational process according to the IMO Model Course, and shipping company does not implement appropriate maintenance plan. Based on the root causes, organizational factors can be the root causes of ship collisions**.

Keywords—Risk, accidents, ship collision, safety, organizational

I. INTRODUCTION

Ships as sea transportation have an important role in the distribution of goods and support the growth of world trade. In line with the growth of world trade, ships have grown in capacity, volume and types of goods transported. This condition has an impact on the development of the shipping industry [1]. The growth of the shipping industry is not in line with the increase in marine safety, many ship collisions occur in Indonesian waters. Ship collision in Indonesian waters is very high. Based on data from the Coastal Guard, the Ship collisions that occurred in 2010 to 2017 are 46 cases [2] Every accident will have direct and indirect impacts. The direct impact is material loss and loss of life, while the indirect impact is the psychological condition of the accident victim and the economic condition of the victim's family.

Protection of ship crew, environment, ships, and cargo play a central role in shipping safety system. Through regulations, empowerment of human resource and deployment of appropriate technologies form a shipping safety system with an objective to reduce and prevent accidents. Nevertheless, accidents remain difficulty to be avoided, as it is possibility to happen is always around us. This condition indicates that the implementation of the solutions provided has not been at the root cause of ship accidents so that the preventive action has not been able to reduce the number of ship accidents.

A number of studies on ship accidents show various factors which have caused shipping accidents [3]. Most of the collisions accidents are caused by bad visibility (environmental factors), wrong decision making, poor communication between ships or between bridge crew, the crew does not focus during watch keeping and does not comply with the Safety Management System [4].

[5] and [6] in their study found that the humans are a major contributor to accidents. According to statistical data, the percentage of causes of accidents due to human error is 80% - 85% [7] and [8]. Less competence of the crew, negligent, old ages, can make the cause an accident [9]. Lack of rest can make the ship’s crew in fatigue and will have an impact on decreasing the alertness while they in watch keeping [10] and [11].

[12] Developed a Bayesian Network model uses to analyze cause of ship accident. He concluded that collisions depend strongly on human factors.

Australian Transport Safety Bureau (ATSB), found human and organization factor to be a primary cause of collisions and sinking ship. The sinking is caused by the lack of communication between the bridge crew and the ship collision caused by there is no collision prevention procedures [13] and [14]. The study on the MV SEWOL accident showed that accidents could occur if the organization failed to identify the ability of the crew and placed the crew that could not to handle dangerous situations on board [15]. This paper aims to analyze organizational factor in ship collisions.

II. METHOD

The HOR phase 1 method identifies the risk agent in critical category that are priority for preventive action [16]. The risk agent is the cause of the risk event, and the risk event is the direct cause of the ship accident. This method begins with assessing the severity of risk events, occurrence of risk agents, and the relationship between risk events and risk agents. The assessments are given by shipping experts. After that do the Aggregat Risk Potential (ARP) calculation. The process of HOR Phase 1 consist of:

2.1 Identification of Risk Events RE and Risk Agents.

46 ship collisions in the investigative report were reviewed to find risk events (RE) and risk agents (RA). After that, RE and RA were validated through discussions with shipping experts.

2.2 Severity Assessment

Severity value is obtained from risk events assessment bases on categories:

- If the risk of a ship accident contribute to ship damage is ≤ 50%, the accident is classified as a low risk and given a number of 1 (one).
- If the risk of a ship accident contribute to ship and load damage ≤50%, the accident is classified as a moderate risk and given a number of 2 (two).
- If the risk of a ship accident contribute to ship and load damage is ≥ 50%, the accident is classified as a high risk and given a number of 3 (three).
- If the risk of a ship accident contribute to 100% loss of ship, 100% loss of load, and fatalities the accident is classified as a very high risk and given a number of 4 (four).

2.3 Occurrence Assessment

Occurrence value is obtained from risk agents assessment bases on categories:

- If a ship accident occurs a time in a month, the category of accident assessment is rare and given a number of 1.
- If a ship accident occurs twice in a month, the category of accident assessment is rare and given a number 2.
- If a ship accident occurs between three times to five times in a month, the category of accident assessment is rare and given a number 3.
- If a ship accident occurs more than five times in a month, the category of accident assessment is rare and given a number 4.

2.4 Relationship Assessment Between Risk Event and Risk Agents

Assessment of the relationship refers to (0; 1; 3; 9) categories. The meaning of the categories is: 0 means no relationship, 1 is a weak relationship, 3 is a strong relationship, and 9 is a very strong relationship.

2.5 Aggregat Risk Potential Calculation

Aggregat Risk Potential Calculation (ARP) describes the conditions of risk agents. The ARP value is calculated using the formula:

$$ARP_j = O_j \ x \ \sum(S_j \ x \ R_j) \quad (1)$$

Description:
ARPj : Aggregate Risk Potentials of a risk agent.
Oj : Occurrence value.
S_j : Severity value.
R_j : Relationship between a risk event and risk agents

From the results of the ARP calculation, then the ranking is carried out from the largest value to the smallest value.

2.6 Identyfing Risk Agents in Critical Category

To identify the RA in critical category use 80/20 rule in a Pareto Chart. The rule has the understanding that about 20% risk will cause 80% effects.

III. RESULT AND DISCUSSION

Based on review investigating report, identified 3 (three) risk events and twelve RA. The RE are the number and condition of navigation equipment are inadequate (RE1), crew is in doubt during navigating (RE2), and duty during watch keeping is not conducted carefully (RE3). The risk agents are navigation equipment does not work well (RA1), radar is not calibrated (RA2), map is not updated (RA3), navigation equipment is incomplete and inadequate (RA4), navigation equipment surveys are not carried out regularly (RA5), communication equipment does not work well (RA6), crew competence is minimal (RA7), crew has less sailing experience (RA8), crew is not familiar with shipping operations (RA9), port is a congested (RA10), crew is in fatigue condition

(RA11), and number of crew is less than required by regulation (RA12).

In the assessment of severity, the value of risk agents is obtained. The severity value consists of: RE1 has value of 2.77, RE2 has value of 3.20, and RE3 has value of 2.73. Result of the occurrence assessment of risk agents namely RA1 has value of 2.40, RA2 has value of 2.63, RA3 has value of 2.50, RA4 has value of 2.57, RA5 has value of 2.33, RA6 has value of 2.57, RA7 has value of 2.17, RA8 has value of 2.33, RA9 has value of 2.53, RA10 has value of 2.63, RA11 has value of 2.40, and RA12 has value of 2.93. Base on level of loss and chance of a ship collision, the risk events is in high risk criteria, and the risk agents is in often criteria.

The results of the assessment of the relationship between RE and RA provided by shipping experts consist of: Relationship between RE1 and RA1 has value 9 (very strong relationship), relationship between RE1 and RA2 has value 9 (very strong relationship), relationship between RE1 and RA3 has value 3 (strong relationship), relationship between RE1 and RA4 has value 9 (very strong relationship), relationship between RE1 and RA5 has value 9 (very strong relationship), relationship between RE1 and RA6 has value 1 (weak relationship), relationship between RE2 and RA7 has value 9 (very strong relationship), relationship between RE2 and RA8 has value 3 (strong relationship), relationship between RE2 and RA9 has value 1 (weak relationship), relationship between RE2 and RA10 has value 1 (weak strong relationship), relationship between RE3 and RA11 has value 1 (strong relationship), and relationship between RE3 and RA12 has value 1 (weak strong relationship). The relationship that has value 9 describes the risk agents is very strong as a cause of risk events.

Based on the severity value, the occurrence value, and value of relationship between RE and RA, the ARP calculation is carried out. From the calculation obtained the value of ARP consist of: RA1 has value of 62.25, RA2 has value of 65.49, RA3 has value of 20.75, RA4 has value of 63.99, RA5 has value of 63.00, RA6 has value of 7.11, RA7 has value of 62.50, RA8 has value of 22.37, RA9 has value of 8.10, RA10 has value of 8.42, RA11 has value of 19.66, and RA12 has value of 7.92. From the calculation can be seen the highest value is 63.99 and the lowest value is 7.11.

Critical RA is obtained by calculating the percentage of cumulative ARP value, then analyzed using Pareto Chart (can be seen in Fig. 1).

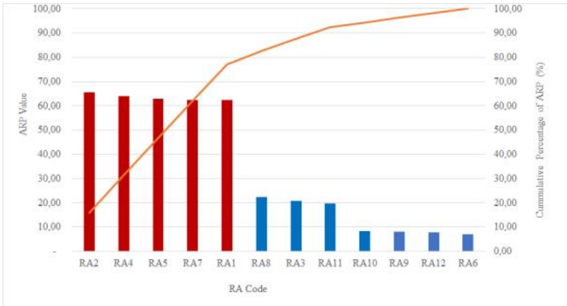

Fig. 1. Pareto Chart

Based on Pareto rule (80/20), there are five RA in critical category (Fig. 1). The RA are radar is not calibrated (A2) has cumulative percentage is 15.91, Navigation equipment is incomplete and inadequate (A4) has cumulative percentage is 31.46, Navigation equipment surveys are not carried out regularly (A5) has cumulative percentage is 46.77, crew competence is minimal (A7) has cumulative percentage is 61.96, and Navigation equipment does not work well (A1) has cumulative percentage is 77.08.

The root cause of the ship collision was obtained through root cause analysis which can be seen in Fig. 2.

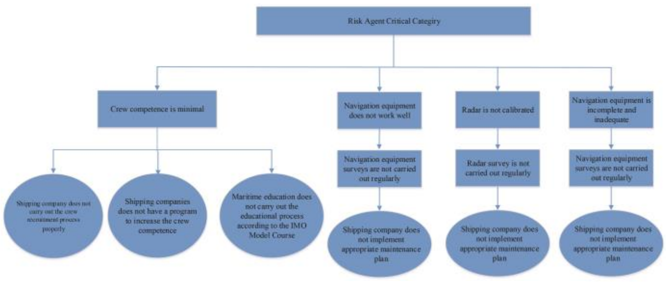

Fig. 2. Root Cause Analysis

In Fig. 2, can be seen, there are four risk agents in critical category, consist of crew competency is minimal, navigation equipment does not work well, radar is not calibrated, and navigation equipment is incomplete and inadequate. Crew competency is minimal caused by the shipping company does not carry out the crew recruitment process properly, shipping companies does not have a program to increase the crew competence, and maritime education does not carry out the educational process according to the IMO Model Course. Navigation equipment does not work well caused by survey of navigation equipment are not carried out regularly, and then survey of navigation equipment are not carried out regularly caused by shipping companies does not implement appropriate maintenance plan. Radar is not calibrated caused by survey of radar is not carried out regularly, and the radar is not carried out regularly caused by shipping company does not implement appropriate maintenance plan. Navigation equipment is incomplete and inadequate caused by survey of navigation equipment are not carried out regularly, and the survey of navigation equipment are not carried out regularly caused by shipping company does not implement appropriate maintenance plan.

IV. CONCLUSION

There are four root causes of ship collisions, namely The shipping company does not carry out the crew recruitment process properly, shipping companies does not have a program to increase the crew competence, maritime education does not carry out the educational process according to the IMO Model Course, and shipping companies does not implement appropriate maintenance plan. Shipping companies and maritime education are organizations that can cause ship collisions.

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