

RISK MANAGEMENT ON THE WARSHIP TASK OPERATIONS

Mukhlis¹, Diksono², Suparno³

Sekolah Tinggi Teknologi Angkatan Laut,
STTAL-Bumimoro-Morokrembangan, Surabaya 60187, Indonesia
Email: sonodik@gmail.com
Orchid id 0000-0002-1492-1025

ABSTRACT

The main task of the Indonesia Navy is to enforce the law and maintain security in the territorial sea of national jurisdiction, so that the Indonesian Navy is required to have the main tool of weapons systems (Alutsista) are always ready to carry out the task. The frequent occurrence of accidents experienced by the Indonesian Warship (KRI). This reduces the ability of Warship in performing the task. The purpose of this research is to investigate the causes and effects of accidents, and seek risk mitigation that is considered appropriate. Formal Safety Assessment (FSA) is a structured and systematic methodology used for maritime safety analysis. The fault tree analysis is used to investigate the cause of marine accidents and the event tree analysis is used to determine the impact of an accident. The results of this study are FSA can be effectively applied in accident investigations, although the calculation of cost benefit analysis for warships can be ignored because the Warship task cannot be compared to the value of money.

Keywords: Task Operation, Warship, FSA, fault tree analysis, event tree analysis

1. INTRODUCTION.

Indonesia is an archipelagic country with the area of the total national jurisdiction $\pm 8,308$ million km² (Pushidrosal, 2017). The extent of Indonesia's territorial waters has potential threats to ideology, politics, economics, social culture, defense and security. To deal with these threats, adequate defense capabilities is needed. The unity and integrity of the Unitary Republic of Indonesia are a fixed price that must be championed and defended. Faced with this responsibility, the Indonesian Navy as an element of the TNI (Indonesian national army) force responsible for NKRI's (The Unitary State of the Republic of Indonesia) defense operations at sea, is required to be able to carry out tasks through fostering strength with emphasis on power structures through the SSAT (Putra, et al., 2017).

Warships as one of the main elements of the SSAT are required to have an adequate combat readiness to counter every threat. It is necessary to maintain and improve the condition of warships, so that they are always ready to carry out operations. A marine security patrol was carried out by presenting Warship in all Indonesian waters, including on remote islands. The aim is to carry out routine patrols in the context of enforcing maritime security and maintaining territory from foreign parties (Marsetio, 2014).

Safety and health personnel and material work is an important thing that is always considered in the line of duty regional security. An accident is one of the things that need to be avoided because they cause various losses to the organization. Marine accidents have a negative impact on humans, the environment, activities on board and

land in a wide variety of forms and levels, and the effects vary from minor injuries to fatalities and environmental damage and mild to severe property (Mullai & Paulsson, 2011)

We know many accidents that befall Warship. The condition of being trigger reasons the capabilities of crew members of a vessel which is very limited, the condition of Warship having the age of 40 years, a limited number of maintenance and so on. Many fleets of ships are made of fiber, which in terms of specifications are not in accordance with military standards, and the amount that does not meet the demands of the ship's need to carry out operations. Sources of risk to the marine system include equipment failure, external events, human error, and institutional errors (Ayyub, et al., 2002).

Risk management learns how to identify, analyze, evaluate, treat and monitor hazards in Warship operations. Risk management aims to minimize losses that must be borne by an organization (Australian/New Zeland Standart, 2004). Currently it can be developed and proposed for further research, including further detailed risk analysis and analysis of costs and benefits (Mullai & Paulsson, 2011). The ability to define what might happen in the future, assess the risks and uncertainties associated with and choose between alternative, alternatives lies in the core of the risk management system (Kishore, 2013). The risk management process based on Figure 1.

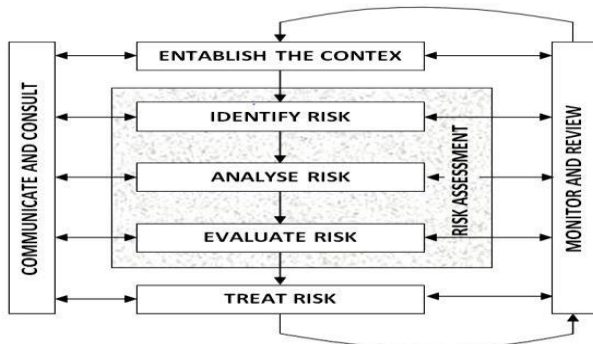


Fig. 1 Risk management process
(Australian/New Zeland Standart, 2004)

Based on several international and national rules, warships are classified as non-conventional vessels or special ships. The rule is that warships are not bound by rules such as the rules as previously mentioned. In carrying out sailing and operating activities, Warship requires rules that must be made not lower than the rules of international conventions. The lack of specific rules that apply to Warship's operating activities cause system management weaknesses, especially those that regulate risk management related to safety and health for personnel and material. Adoption of risk management throughout the ship life cycle, design and operation can provide best practices to reduce risk (Gasparotti & Rusu, 2012). To maximize marine safety, risks need to be modeled and safety-based decisions must be made in a logical manner (Wang, 2002).

The main problem is how to manage the risks that occur in the implementation of Warship tasks. The purpose of this study is how to use the FSA model to identify, analyze and assess risks that can occur when Warship carries out its operations and then develops risk mitigation scenarios in an effort to reduce risk.

The international shipping industry has adopted a proactive approach to establishing safety rules through Formal Safety Assessment (FSA). The FSA was introduced by IMO as a structured and systematic methodology that was used for maritime safety analysis and to formulate safety related policies. The FSA was introduced by IMO as a structured and systematic methodology that was used for maritime safety analysis and to formulate safety related policies. Shinoda and Tamura reported that the FSA was an effective methodology developed and applied to investigate ship accidents (Shinoda & Tamura, 2012). The FSA aims to improve maritime safety, including protection of marine life, health, environment and property, using risk analysis and assessing costs and benefits as

well as several risk control options (International Maritime Organization, 2002). FSA can be used as a tool to evaluate new safety regulations or make comparisons between regulations to be improved (DNV, 2002). The FSA consists of the following steps:

- a. Hazards identification.
- b. Risk analysis.
- c. Risk control options.
- d. Cost benefit assessment.
- e. Recommendations for decision-making.

The analysis phase uses the fault Tree Analysis (FTA) and Event Tree Analysis (ETA) models. Fault Tree Analysis is a technique used to identify risks that contribute to failure or accident (Mullai, 2006). FTA is the easiest method to understand in finding the core of the problem (Soares, 2012). Event Tree Analysis is a logic diagram used to analyze the effects of accidents, failures or unwanted events (Mullai, 2006). In principle FTA and ETA techniques are the most suitable principles for applications in risk analysis in marine transportation (Mullai & Paulsson, 2011).

2. MATERIAL/METHODOLOGY

Scientific research requires a systematic framework in order to ease the course of the research. The research framework must be structured according to the issues reviewed. For more detail research methodology displayed in Figure 2.

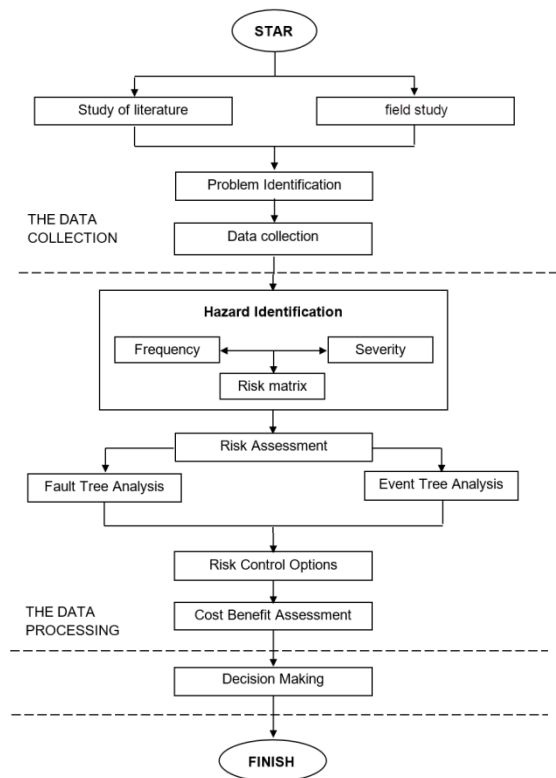


Fig. 2 Stock Flow

On stage data collection, the data collected in the form of qualitative. The qualitative method is a better choice at early stages of study (Jieying, 2013). The data of accidents were collected from the records of the operations staff, previous research and various kinds of media that were considered to support the research. The preliminary data is the data of accident events experienced by Warship as a problem as illustrated in Table 1. Furthermore, the data are processed and combined with supporting data obtained through the assessment of experts. The experts are personnel who are considered competent in that section.

Table 1. Warship accident data

	TYPES	YEAR																		AMOUNT	
		18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01		00
1	Ship collision by ship			1								1							2		4
2	Ship collision with a wharf				1																1
3	Crashing a floating object		3	2									1	3	1						9
4	Aground			1	1										1		1	2			6
5	Leakage		1	2	2					1	1								1		8
6	Sink			1	1		1		1	1	1								1	1	8
7	Fire			2	2			1		1											6
8	Human Accident					1		1													2

3. RESULTS AND DISCUSSION

In accordance with the FSA procedure, the stages of the steps are carried out:

a. Determination of consequence criteria value

In this phase identified several species of accident often experienced of them are:

1. Ship collision by ship
2. Ship collision by wharf
3. Crashing a floating object
4. Aground
5. Leakage
6. Sink
7. Fire
8. Human Accident

Of the several types of accidents identified, there are several components that are at risk of receiving the impact of the accident, including Warship, crew, property, environment, and third parties in this case shipping service users. The next step is to determine the consequence criteria based on expert judgment and several standards that have been determined as shown in Table 2.

Table 2. The criteria for a consequence an accident of Warship

Severity	Warship	Crew	Property	Shipping Users	Environment
Catastrophic	1 Can not re-implement regional security tasks?	Multiple violent deaths and / or widespread fatal disease	Total loss	Disasters (the scope is international, the port is closed, the voyage is disrupted for long periods Serious and happiness for a long time, no trade)	Uncontained or Widespread damage
Fatal / Critical	2 Guard duty delayed maximum a month	Single death and / or multiple severe injuries or severe occupational illness	Major system Loss	The national scope, the port temporarily closed from the cruise for several days. Here is no trading	Major damage
Severe / Marginal	3 Guard duty delayed maximum 7 days	Single severe injury or occupational illness and / or multiple minor injuries	Controlled System Damage	Stop temporary shipping or extension of shipping restrictions	Controlled short-Term damage
Minor / Negligible	4 Duty of security got delayed for some time	Minor injury / occupational illness	Minor damage	Short term losses	Minor local damage

To determine the impact weight borne by the recipient of the risk, an assessment was carried out by experts, the continuation of the data was processed using the Analytical Hierarchy Process (AHP) method, so that the weighting results obtained in accordance with Table 3.

Table 3. The weighting of risk recipients

Criteria	Weight
Warship	0,458
Crew	0,285
Property	0,054
Environment	0,150
Shipping users	0,053

Hazards Identification

At this stage we make a list of all accident scenarios that are relevant to potential causes with values based on the level of risk and its consequences. The method used is creative techniques and analysis that is by expert judgment or literature study. The intended value is the level of risk based on consideration of risk criteria for receiving ALARP according to Figure

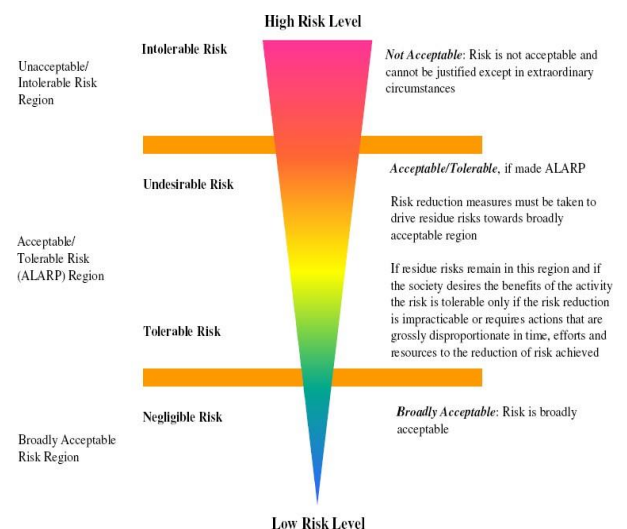


Fig. 3 The framework the reception of the risk and strategies the actions of risk management

By combining the level of consequence (Table 2) and frequency (Table 4) of occurrence, it obtains the severity level matrix. To sort the types of accidents that need to get priority handling, the risk matrix is multiplied by the recipient's risk weight which results in accordance with Table 5.

Table 4. Frequency of hazard (The Royal Institution of Naval Architects, 2010)

FREQUENCY		DEFINITION
Frequent	1	Continuously occurs
Probable	2	Likely to occur repeatedly
Occasional	3	Likely to occur several times during the operational life of the system
Remote	4	Likely to occur at some time in the system life-cycle
Improbable	5	Unlikely to occur during operational life
Incredible	6	Extremely unlikely to occur (but beware assuming this means never)

Table 5. The value of severity Warship accident

Number	Hazard Type	The Biggest Possible Consequences					Possible Consequences Worst					Amount	Rank
		Hazard Impact Assessment					Hazard Impact Assessment						
		KRI	Crew	Property	Environment	Shipping users	KRI	Crew	Property	Environment	Shipping users		
1	Ship collision by ship	2,747	1,426	0,272	0,750	0,263	2,747	1,426	0,326	0,600	0,316	10,873	5
2	Ship collision with a wharf	1,831	1,141	0,218	0,600	0,211	2,747	1,426	0,326	0,750	0,316	9,565	8
3	Crashing a floating object	2,289	1,426	0,272	0,750	0,263	2,747	1,426	0,326	0,750	0,263	10,512	6
4	Aground	2,747	1,712	0,381	0,900	0,316	2,747	1,426	0,381	0,900	0,316	11,824	4
5	Leakage	3,204	1,712	0,326	0,900	0,316	4,120	1,997	0,435	1,050	0,316	14,375	3
6	Sink	4,120	1,997	0,490	1,050	0,368	4,120	2,282	0,490	1,199	0,421	16,536	1
7	Fire	3,662	1,997	0,435	0,900	0,368	3,662	1,997	0,435	0,900	0,368	14,724	2
8	Human Accident	1,831	1,712	0,218	0,600	0,211	2,747	1,997	0,218	0,600	0,211	10,342	7

Based on these calculations five types of accidents are taken that have a high risk that requires risk mitigation measures. The five types of accidents are:

1. Sink
2. Fire
3. Leakage
4. Aground
5. A collision with a ship

b. Risk Analysis

The purpose of this risk analysis is to investigate in detail the causes and consequences of the scenarios identified in the hazard identification step. This analysis is focused on high- risk areas.

1. Fault tree analysis

Fault tree analysis is used to determine the common causes of accidents that experienced Warship. Various causes of accidents can be seen in Figure 4 to Figure 8

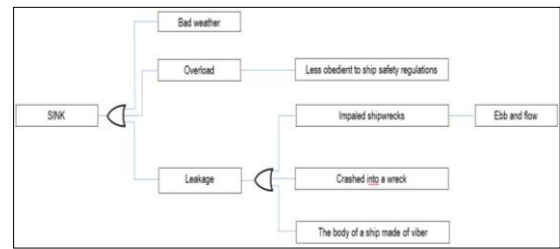


Fig. 4 Fault tree analysis sinks

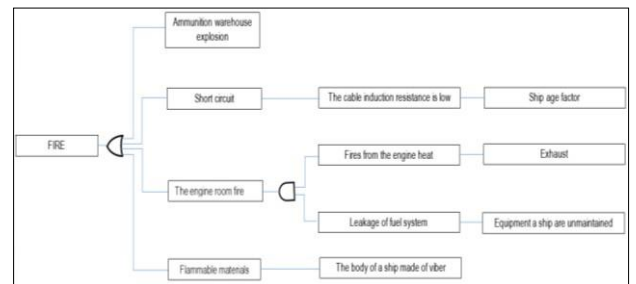


Fig. 5 Fault tree analysis fire

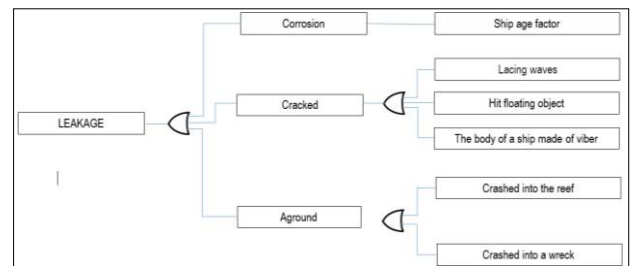


Fig. 6 Fault tree analysis leakage

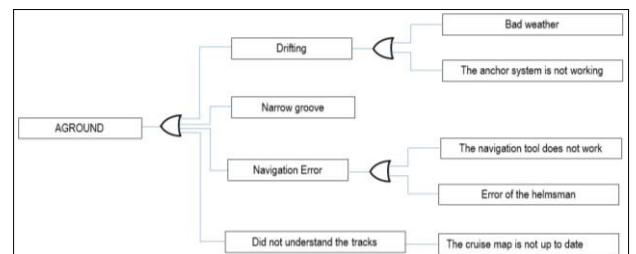


Fig. 7 Fault tree analysis aground

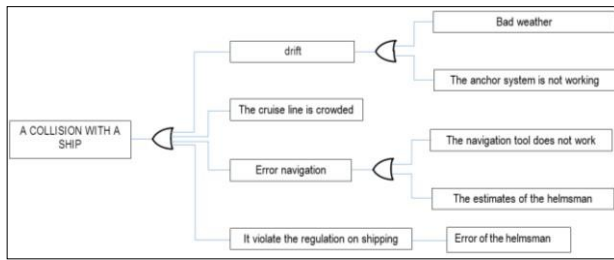


Fig. 8 Fault tree analysis a collision with a ship

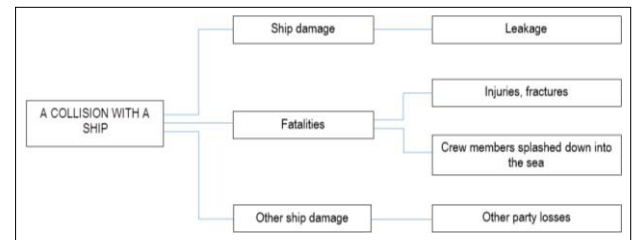


Fig. 13 Event tree analysis a collision with a ship

1. Event tree analysis

Event tree analysis is used to determine the impact of the accident experienced by Warship. Various impacts of accidents can be seen in Figure 9 to Figure 13.

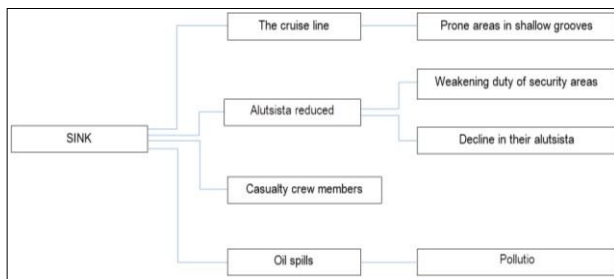


Fig. 9 Event tree analysis sinks

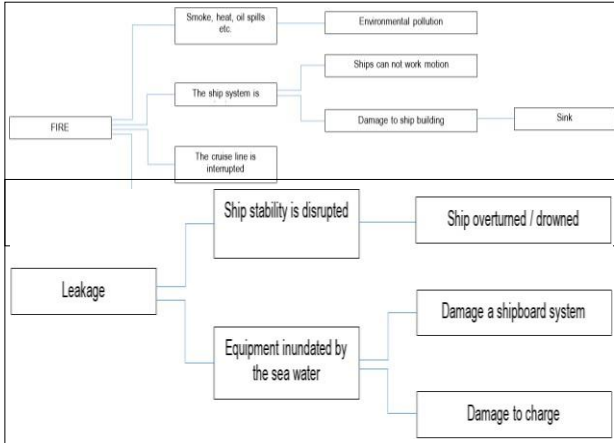


Fig. 11 Event tree analysis leakage

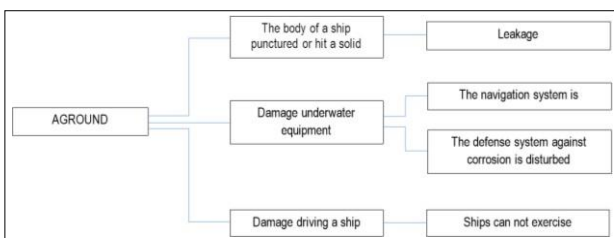


Fig. 12 Event tree analysis aground

c. Risk Control Options

The aim of the RCO step is to propose effective and practical risk control options. There are several steps could be done to reduce the risk of:

1. Seaman training and certification (PSP)
2. Ship rescue training (PPK)
3. Human rescue training (PPM)
4. Improved quality control and periodic inspections (PMI)
5. Preparation of ship maintenance schedule (PJP)
6. Fulfillment of personnel according to DSP (PJM)
7. The purification of the reporting system (PSL)

d. Cost Benefit Assessment

In principle, the calculation of costs carried out follows the equation widely used in FSA applications called Gross Cost of Averting a Fatality (GCAF) expressed in the form (Kontovas & Psaraftis, 2009):

$$GCAF = \frac{\Delta C}{\Delta R} \quad (1)$$

ΔC : Cost of risk control

ΔR : Risk reduction after risk control

For the calculation of the estimated cost of activities is only activities that can be calculated mathematically, while for activities that are task routines are not calculated.

Table 6. Cost and risk reduction calculation tables

	Risk Control Option	Cost	Risk Reduction	Description
1	Seaman training and certification (PSP)	438.660.000,-	27,09%	
2	Ship rescue training (PPK)	383.700.000,-	30,84%	
3	Human rescue training (PPM)	203.420.000,-	5,16%	
4	Improved quality control and periodic inspections (PMI)		18,50%	Follow-up maintenance system
5	Preparation of ship maintenance schedule (PJP)		30,84%	Customized to the budget
6	Fulfillment of personnel according to DSP (PJM)		12,34%	DSP is a list of personnel arrangements
7	The purification of the reporting system (PSL)	10.192.000.000,-	21,59%	

To choose the best of several types of risk reduction efforts that exist as in Table 4, we can choose by looking at which types of countermeasures have the lowest ICAR index. This is based on the smaller the ICAR value, the better the effectiveness of risk mitigation carried out on risk reduction.

e. Recommendations for decision-making

Actions to reduce the risk of accidents experienced by Warship can be recommended to decision makers as follows:

1. Ship rescue training (PPK) with the ICAR index RP. 12.441.634,-
2. Seaman training and certification (PSP) with the ICAR index RP. 16.192.691,03
3. Being something that needs to be understood, that the measure of regional security is an absolute thing that cannot be measured by nominal money. Even though it is calculated as economically detrimental, but in terms of benefits it is considered very large, it can be a decision that is considered appropriate.

4. CONCLUSION.

From the results of the analysis, the following conclusions were obtained:

a. The Hazard Identification process produces eight types of accidents that often occur when Warship performs operations. The eight types of accidents, there are five types of accidents that have the highest risk that is:

1. Sink
2. Fire
3. Leakage
4. Aground
5. Collision with a ship

b. Each accident is caused by several factors reflected in a fault tree analysis that is largely due to human error. While the impact of the top event is reflected in the event tree analysis. The main impact that must be borne is the ability of Warship operations to be reduced, so that the task of safeguarding the territorial waters becomes less optimal.

The FSA is a structured and effective methodology in managing shipping risk management, including for warships, although in calculating the cost and benefit assessment in the military field can be ignored. This is because the task of securing territorial waters cannot be assessed with money.

5. REFERENCES

- Australian/New Zealand Standart, 2004. *Risk Management AS/NZS 4360:2004*. s.l.:s.n.
- Ayyub, B. M., Beach, J. E., Sarkani, S. & Assakkaf, I. A., 2002. Risk Analysis and Management for Marine Systems. *Naval Engineers Journal*, p. 181–206.
- DNV, 2002. *Formal Safety Assessment - Large Passenger*, s.l.: s.n.

Gasparotti, C. & Rusu, E., 2012. Methods for The Risk Assessment in Maritime Transportation in The Black Sea Basin. *Journal of Environmental Protection and Ecology*, pp. 1751-1759.

International Maritime Organization, 2002. *Guidelines for Formal Safety Assessment (FSA) for Use in The IMO Rule-Making Process*. London: s.n.

Jieying, X., 2013. *Study on the implementation of formal safety assessment for the development of the mandatory polar code*, Malmö: World Maritime University.

Kishore, E. A., 2013. *Formal Safety Assessment in Maritime Industry-Explanation to IMO Guidelines*. [Online] Available at: www.researchgate.net [Diakses 14 Januari 2018].

Kontovas, C. A. & Psaraftis, H. N., 2009. Formal Safety Assessment: A Critical Review. *Marine Technology*, p. 45–59.

Marsetio, 2014. *Sea Power Indonesia*. Jakarta: Universitas Pertahanan.

Mullai, A., 2006. *Risk Management System - Risk Assessment Framework and Techniques*. 5 penyunt. Turku: Dagob.

Mullai, A. & Paulsson, U., 2011. A grounded theory model for analysis of marine accidents. *Accident Analysis and Prevention*, Volume 43, p. 1590–1603.

Pushidrosal, 2017. *Data of the Territory of the Unitary State of the Republic of Indonesia*, Jakarta: Pushidrosal.

Putra, I. N., Hakim, A., Pramono, S. H. & Tolle, H., 2017. Adopted COBIT-5 Framework for System

Design of Indonesia Navy IS/IT: An Evaluation. *International Journal of Applied Engineering Research*, 12(17), pp. 6420-6427.

Shinoda, T. & Tamura, Y., 2012. Development of Risk Assessment Based on FSA and ITS Application Collision Between Fishing Vessels and Cargo Vessels. *Seminar Nasional Teori dan Aplikasi Teknologi Kelautan*, pp. 19-25.

Soares, A. P. T. a. C. G., 2012. *Fault Tree Analysis*. Fault Tree Analysis, s.l.: Instituto Superior Techno.

Wang, J., 2002. Offshore safety case approach and formal safety assessment of ships. *Journal of Safety Research*, Volume 33, p. 81 – 115.