INDONESIAN'S SHIP SAFETY ASSESSMENT STRATEGY

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ABSTRACT
Indonesia is the world's largest archipelago, 2/3 of the country is covered by sea. But due to many factors a lot of ship accidents occurred every year, and claiming a large number of casualties. Efforts have been done to improve the safety of domestic sea transportation, as the result to be fully compliance to the SOLAS regulations, worsen by the varying sea and cargo characteristics, and low educated passengers, they are very vulnerable to accidents. Research is being carried out to explore the most appropriate strategy for ensuring the safety of ship operating on Indonesian waters using various methods, where four most influencing aspects i.e. Software, Hardware, Environment, and Live-ware are put into considerations. The existing conditions and experience learned from the past, backgrounds and sources of accident/incident are investigated, based on the findings feasible strategy is proposed, which will include the design requirements; qualification of personnel, refined rules, and operational efficiency.

Keywords: *assessment, safety, strategy, Indonesia.*

1. INTRODUCTION

Majority (80 to 85%) of all recorded maritime accidents are generally attributed to human error or associated with human error. Most of the accidents are the result of senseless and avoidable human errors. The concern about human factors is growing as human error is significantly implicated in so many marine accidents. Eighty percent or more of major marine accidents were caused by humans and organizations that influence the individual. Similarly, once an accident sequence has initiated, it is the organizational influences that allow the sequence to continue, resulting in an accident. The culture, incentives, and operating methods of organizations have important effects on the safety of marine systems.

Detailed analysis of the causes of accidents involving complex technological systems clearly indicates that a small percentage of the major catastrophic accidents are caused by failures of the structures or hardware components of the system (something less than 20%). This is the tribute of the technology. Rather, the accidents that are caused by unanticipated actions of people have undesirable outcomes (something more than 80%). A lot of ship accidents occurred every year on Indonesian waters, described in Table 1, and the number of accidents in Table 2.

Table 1. Number of Ship Accident according to Marine Court Decision

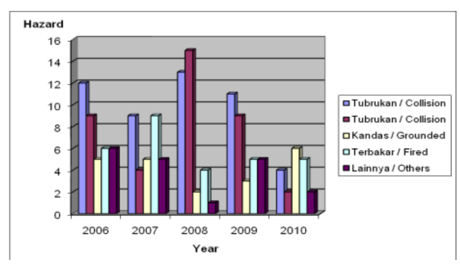
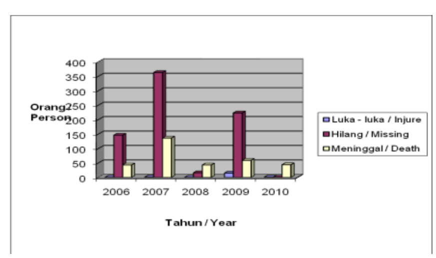


Table 2. Number of Victims according to Marine Court Decision



2. FORMAL SHIP SAFETY ASSESMENT

By considering the main characteristics of ship a formal safety assessment can be described as:

2.1 Hazard Identification

The term "hazard" is defined as "an undesirable outcome in the process of meeting an objective, performing a task or engaging in an activity (Kuo, 1998). The objective of this step is to derive a list off all relevant accidents scenarios, together with their potential causes and outcomes. To achieve this, many typical techniques are employed to identify the hazards, which might contribute to the occurrence or escalation of each accident scenario. These techniques include Brainstorming, Hazard and Operability Studies (HAZOP), and Failure Mode and Effect Analysis (FMEA).

Potential hazard identification described in Table 3, with regard to the operation. Once the hazards are identified, with respect to each of the categories shown in Table 3, it is essential to carry out a "Probability Assignment" (Passenger Vessel Association, 1997) in order to rate the impact of that hazard occurring. Five scales are used for the Probability and Consequence Assignments" and shown in Table 4 and 5.

Table 3. Potential Hazard Identified

Casualties	Description
Personnel	Crew injury
	Man overboard
	Medical emergency
	Passenger injury
	Passenger Violence
	Slip and fails while underway
Material-ship	Galley fire
	Fire/explosion on board
	Collision/ grounding due to human error
	Engine room/ machinery space fire
	Flooding and/or sinking due to hull failure
Material-shore	Fire in terminal
	Explosion in terminal
	Structural damage to terminal
Environmental impacts	Exhaust emission
	Noise
	Oil pollution due to vessel accident
	Pollution due to oil discharge

Table 4. Frequency Assignment

Assign a rating of:	If the frequency is:
1	Remote = might occur once in a life time
2	Occasional = might occur in every five years
3	Likely = might occur every season
4	Probable = might occur monthly
5	Frequent = might occur weekly or daily

Table 5. Consequence Assignment

Assign a rating of:	If the impact could be:
1	Negligible : injury not requiring first aid, no cosmetic vessel damage, no environments impact, no missed voyage
2	Minor : injury requiring first aid, cosmetic vessel damage, no environmental impact, no missed voyage
3	Significant : injury requiring more than first aid, vessel damage, some environmental damage, a few missed voyage or financial loss
4	Critical : severe injury, major vessel damage, major environmental damage, missed voyage
5	Catastrophic : loss of life, lost of vessel, extreme environmental impact

2.2 Risk Assessment

The objective of the second step is to evaluate the factors contributing to the risk associated with each hazard on the prioritized list. This step includes consideration of the various factors (such as training, design, communication and maintenance), which influence the level of risk.

2.3 Risk control options : devising regulatory measures to control and reduce the identified risks.

2.4 Cost benefit assessment : determining cost effectiveness of each risk control option.

2.5 Recommendations for decision-making : information about the hazards, their associated risks and the cost effectiveness of alternative risk control options is provided.

3. SHIP Safety strategy

The ship safety strategy is developed based on the four aspects of potential hazards sources namely Software, Hardware, Environment, and Live ware.

Each of aspect is then elaborated further into several variables. Here, the identified variables are then assessed by putting the potential hazards into safety risk categories. Generic Management System model is used for the assessment. The outline is described in Figure 1.

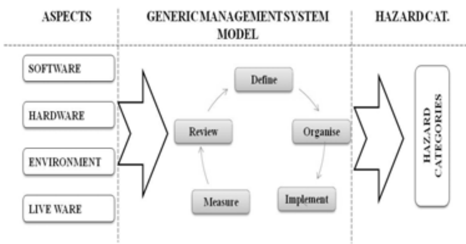


Figure 1. Safety Assessment Model

The four aspects of potential hazards sources are elaborated as follows:

4.1. Software

Included in the Software are: the organization, management, rules and regulation, and operating system.

4.1.1. The Organization

The organization includes the organization of the ship company, the organization of the port authority, and the organization of the ship.

4.1.2. The Management System

Management system is a framework for managing and continually improving organization's policies, procedures, and processes that will transform the input into desired output. The management system usually involves 5 following steps loop:

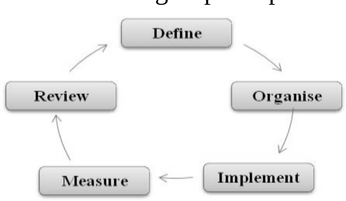


Figure 2. Management system loop

Step 1 - DEFINE : The goal and policies

Step 2 - ORGANISE : Resources; plan the work and assign responsibilities to different people

Step 3 - IMPLEMENT : In practice the policies in order to achieve the goal

Step 4 - MEASURE : Performance by "active" methods

Step 5 - REVIEW : The results obtained and experience gained.

Step 5 will then to be used as feedback for refining the whole process from the beginning. This management system should be applied into all aspects of the ship management in order to obtain cost effective and safe operation of the ship.

4.1.3. Rules

Rules and regulations are deterministic guidance and instructions that are meant to prevent any accident which might disturb the operational comfort of the ship and harm the people on board. They are issued by governing authorities both local as well as international usually based on the experience learned from past accidents.

4.1.4. Operating Systems

Operating systems are instructions that should be followed by all parties concerned in order to have an effective operational condition, without good operating systems the operation of the ship might end up in chaotic situation and will create hazardous condition, therefore the operating system should be made simple, easy to be understood, systematic, and accessible to the concerning parties.

4.2. Hardware

Included in the hardware are the design and the structure of the ship including the machinery and equipment of the ship, and all land based supporting facilities.

4.2.1. Ship Design and Structure

The design and structure of the ship including all its systems and sub-systems should be assessed using Generic Ship Model, and Topographical Reliability Block Diagram. The Generic Ship Model describes how all the ship functions are built up from subsystems and systems, which is developed by utilizing the model and collected data. The Topographical Reliability Block Diagram gives a basis for the assessment/ design showing lack of system redundancies and effect of fire and flooding situations aboard on top of the actual ship arrangement. Results of the assessment will be recommended for the improvement of the ship safety.

4.2.2. Land Based Supporting Facilities

The land based supporting facilities will determine the safety of loading and unloading both the ship's cargo and the passengers. The condition and efficiency of the facilities should also be assessed using available data and simulation tools.

4.3. Environment

Included in the Environment are the conditions of the weather, wind, wave, current, depth of the sea, traffic condition, and port description. First of all the characteristics of the environment should be investigated using available data and information from the reliable sources, these data are known as the normal environment characteristics. The normal characteristics of the environment should be matched with the safety requirements which are related to the hardware aspects of the safety strategy. Beside the normal environment characteristics the day to day condition of the environment should also be monitored and evaluated by the authorized parties both on board as well as on shore to determine whether the ship is fit for operation.

4.4. Live ware

Included in the live-ware are the ship's crews, the passengers, and the people on shore that have influence to the safety of the ship.

4.4.1. Ship's Crews

Qualifications of the crews to be assign on board should be compliance to the requirement standards, this includes their knowledge, physical and mental condition, and welfare.

4.4.2. Passengers

Passengers' behavior is determined by the cultural, educational, occupational, gender, and ages. Since characteristics of the passengers are usually very different from one place to another, therefore special surveys are needed before any safety procedures are introduced in to the ship operation in relation to the passengers being transported.

4.4.3. People on Shore

Ship safety are not only determined by those who are on board, but at certain extents are also determined by the people on shore, these include port authorities, harbor workers, and land based company's employees, especially those who have influence on the operational of the ships.

All the above aspects are integrated and evaluated to minimize potential hazards as low as possible for any determined conditions of the ship passenger operating on Indonesia waters in a cost affective manner based on the following risks considerations:

Intolerable – These are the risks that should be made as minimum as possible, because they might threaten human lives, and cause major damage to the ship as well as the environment.

Tolerable - These are the risks that might affect the operation of the ship, or bring inconvenience to the passengers, but will not cause major loss.

Ignorable – These are the risks that have no effect both to the operation of the ship and neither the passengers.

5. APPLICATION OF THE STRATEGY

In order to apply the strategy into every aspect of ship safety the aspect being considered should be focused and then every component of the SHEL potential hazard sources are listed into the strategy matrix as follows:

Table 6. Safety Strategy Matrix

SAFETY ASPECT TO BE CONSIDERED			
Software potential hazards	Hardware potential hazards	Environmen t potential hazards	Live-ware potential hazards
Software requirement s	Hardware requirement s	Environmen t readiness	Live-ware requirement s
ACTIONS TO BE TAKEN			

The potential hazard of the ship operation can be categorized as follows:

- Sinking
- Collision
- Grounding
- Fired
- Personnel Accident

The next step is put the potential hazard into risk level categories from 0 to 5 using hazards matrix. Where 0 means no risk and 5 means very high risk. Example of the assessment is shown in figure 3.

ENVIRONTMENT ASPECT	POTENTIAL HAZARD				
	SINKING	COLLISION	GROUN DING	FIRED	PERSONAL ACCIDENT
WEATHER	5	3	3	0	3
WIND	5	4	2	0	4
WAVE	3	3	3	0	4

Figure 3. Example of Safety Assessment

6. CONCLUSIONS

Four major sources for potential safety hazards are identified namely Software, Hardware, Environment, and Live-ware (SHEL), in order to obtain optimum safety strategy for ship. The influence of SHEL sources should be first identified, and requirements for anticipating the risks caused by these sources should be established, and based on these requirements the action plan is proposed.

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