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SAFETY STRATEGY FOR RO-RO PASSENGER FERRIES OPERATING ON INDONESIAN WATERS

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ABSTRACT

Indonesia is the world's largest archipelago, 2/3 of the country is covered by sea, therefore sea crossing transportation modes namely Ro-Ro ferries play very important role for the flow and movement of goods and passengers from and to the islands within Indonesia and the neighbouring countries. But due to many factors a lot of ferry accidents occurred every year, and claiming a large number of casualties. Efforts have been done to improve the safety of domestic sea transportation, but since most of the Ro-Ro ferries are categorized as "Non-convention" ships, as the result these ferries are not enforced 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 Ro-Ro ferries 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**: safety, strategy, Ro-Ro ferry, Indonesia.*

1. INTRODUCTION

As the world largest archipelago Indonesia has more than 17,000 islands, and 95,181 km length of coastal line, 2/3 of the country is covered by sea water. Considering this geographical situation therefore cargo and passenger sea crossing transportation modes namely roll on roll off (Ro-Ro) ferries play very important role for efficient and economical nation-wide flow and movement of goods and passengers from and to the islands within Indonesia territory and its neighbouring countries. But due to many factors such as age of the ferries, sufficient safety knowledge of the human resources, safety awareness of the passengers and other service users, sea and weather conditions, facilities and equipments condition etc.

A lot of ferry accidents occurred every year on Indonesian waters, and claiming a large number of casualties (according to the official recorded data in the period between 2006 and 2010 there were more than 1000 deaths resulting from ferry accidents which concerned everyone) [3]. According to the National Transportation Safety Committee there are 19 major ferries accidents occurred between 2006 and 2010, which consisted:

Table 1. Ferry accident 2006 – 2010

	Occurance	Casualty
Collission	3	n.a
Sinking	4	1,116
Fire	5	29
Grounding	7	N.A

As has been identified by Muchlis et al. [5] that from these accidents 48% are due to human factors, 31% due to environment including weather, and 21% due to technical aspects. According to Jinca [2] the high casualties are mostly due to passengers were not given enough information on emergency access and how to use the safety appliances, sub-standard safety equipment, and improper manning of the ships.

In response to this many efforts have been done by the Government and other stakeholders to improve the safety of domestic sea transportation, such as ratification of the International Maritime Organization (IMO) regulations and codes, establishing National

Safety Regulations, establishing Shipping Laws, improving ports facilities, increasing the knowledge of human resources, continuously monitoring the sea and weather conditions and broadcaststing the forecast to all stakeholders etc. But since most of the Ro-Ro ferries operating on Indonesian waters are categorized as "Non-convention" ships as regulated by the International Maritime Organization, because they are operating on the domestic waters, and most of them are under 500GT, as the result these ferries are not enforced to be fully compliance to the Safety of Life at Sea (SOLAS) regulations, worsen by the varying sea and cargo characteristics, and low educated passengers, they are very vulnerable to all sorts of accidents.

There are around 250 ferries operating on Indonesian waters, consisted of various size, design, building materials, and about 30% of them are considerably old ranging between 15 - 30 years old, more than a half of them are operated by State owned company called Indonesia Ferries, and the rest are owned by private companies. The routes and the number of fleets in every route are regulated by government under the Directorate General of land transport based on the needs of the crossing locations. The routes are divided into 3 main categories i.e. commercial route, pioneer route, and subsidized route [1].

In order to minimise ferry accident including the number of casualties, research is being carried out to set up safety strategy that can be applied to most of the ferries operating in Indonesia.

2. RESEARCH METHODOLOGY

The research is conducted using both qualitative as well as quantitative approaches. The qualitative approach is used to review rules and regulations, and research had been done on related subjects, and the quantitative approach is used to explore and analyse information gathered based on the field surveys.

Some modelling systems are used to explore the most suitable approach in the strategy being proposed, these include Generic Management System Model; Modified SHEL (Software, Hardware, Environment, Live ware) method [6]; and Safety Assessment method, where four most influencing and interrelated aspects on Ro-Ro ferries safety i.e. ship design aspect, ship operational environment aspect, human behaviour aspect, and rules and regulations aspect are put into consideration.

Since the crossing environment conditions, the cargo and passengers characteristics, and the ferries are vary quite significantly from one location to another, in order to get real operational information 4 busiest crossing locations have been selected to be investigated in the research by direct interview and distributing quetionnaires, namely Merak – bakaheuni in Sunda strait between Java and Sumatra islands, Ujung – Kamal in Madura Strait between Surabaya (East Java) and Madura island, Ketapang – Gilimanuk in Bali Strait between Java and Bali islands, and Padang Bai – Lembar in Lombok Strait Between Bali and Lombok islands.

The aims of this investigation is to gather information the conditions of the ferries, the qualifications of the crews, the bahaviour of the passengers, the condition of the ports, and the sea environment of the crossing routes.

3. SOURCES OF ACCIDENTS

The sources of accidents can be divided into internal and external sources. The internal sources are the sources of accidents that come from the ship itself and everything in it, which include the operational of the ship, the cargo being shipped, human influences (intentionally or unintentionally), design and construction of the ship, the arrangement of cargo and passengers; and the external sources are the sources that come from outside of the ship, which include the environment such as the weather, wave and current, collision (hit by other ship), acts of criminals, etc.

The potential accident hazards in the same way can be grouped into four different aspects i.e. software, hardware, environment, and live-ware (SHEL). Software is consisted of organisation, management, rules and regulation, operating system etc, Hardware are consisted of the ship and all its machinery and equipment, land based supporting facilities etc. Environment is consisted of weather, wave, wind, and current. And the live ware is everything relates to human involvement both onboard and onshore.

Since the potential hazards are very much determined by these four aspects, therefore the safety strategy is also developed based on these four aspects.

4. THE SAFETY STRATEGY

The 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.

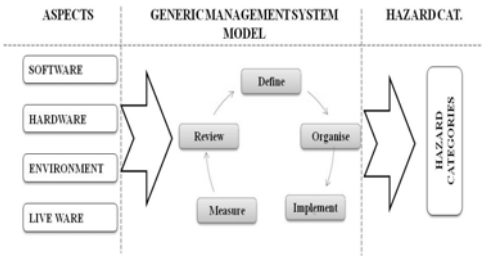

Figure 1. Safety Assessment Model

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

4.1. Software

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

4.1.1. The Organisation

The organisation includes the organisation of the ferry company, the organisation of the port authority, and the organisation of the ship. The structure of each of these organisations will determine the effectiveness of the bureaucracy and how the decisions are being made, this include the manning system and the hierarchical system of the organisation, how the organisation is carried out, how each member of the organisation is interacting one to another, which will directly or indirectly affect the response to the safety requirements.

4.1.2. The Management System

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

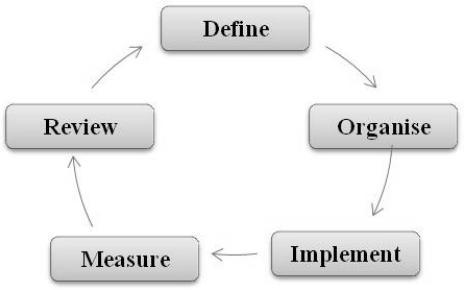

Figure 2. Management system loop

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 and Regulations

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. Rules and regulations are minimum requirements that are applied to common ships and operational conditions, but higher measures should be applied if the situation is beyond the normal conditions, for this purpose Generic Management System Circuit approach that has been developed for addressing any entity that is non absolute, which combines management system circuit and process scheme [4] may be implemented.

There are various rules and regulations to be implemented for the operation of Ro-Ro ferries, that are not applied only for the ship's systems, but also for the people working on board the ship, such as SOLAS, ILO regulations, MARPOL, ISM Codes, ISPS Codes etc.

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 utilising the model and colected 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 authorised parties both on board as well as on shore to determine whether the ship is fit for operation.

4.4. Liveware

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 ferry.

4.4.1. Ship's Crews

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

4.4.2. Passengers

Passengers' behaviour is determined by the cultural, educational, ocupational, 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 Ro-Ro ferry operation in relation to the passengers being transported.

4.4.3. People on Shore

Ferry 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, harbour workers, and land based company's employees, aspecially those who have influence on the operational of the ferries.

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

Untolerable – 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 Ro-Ro safety the aspect being considered should be focussed and then every component of the SHEL potential hazard sources are listed into the strategy matrix as follows:

Table 2. Safety Strategy Matrix

SAFETY ASPECT TO BE CONSIDERED			
Software potential hazards	Hardware potential hazards	Environment potential hazards	Live-ware potential hazards
Software requirements	Hardware requirements	Environment readiness	Live-ware requirements
ACTIONS TO BE TAKEN			

The potential hazard of the Ro – Ro ferries operation can be categorized as follows:

- Grounding
- Collision
- Allision
- Flooding
- Fire
- Sinking
- 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.

ENVIRONMENT ASPECTS	**POTENTIAL HAZARDS**						
	Grounding	**Collision**	**Allision**	**Flooding**	**Fire**	**Sinking**	**Personnel accident**
Weather	5	3	3	4	0	4	3
Wind	5	4	2	2	0	3	4
Wave	3	3	3	4	0	4	4
Swell	3	3	3	4	0	2	3
Current	5	4	3	1	0	3	3
Sea depth	5	1	2	1	0	3	3
Traffict	0	5	4	1	2	1	2
Port	4	4	3	0	2	1	3

Figure 3. Example of Safety Assessment

From the hazard category of the Ro-Ro ferries as result of safety assessment then strategy matrix is created for this aspect and then the actions to be taken are integrated into an action plan as follows:

ACTIONS TO BE TAKEN FOR SAFETY ASPECT 1		
ACTIONS TO BE TAKEN FOR SAFETY ASPECT 2		
ACTIONS TO BE TAKEN FOR SAFETY ASPECT 3	→	ACTION PLAN
....		
ACTIONS TO BE TAKEN FOR SAFETY ASPECT n		

Figure 4. Safety strategy action plan diagram

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 Ro-Ro ferries 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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