CHAPTER 1

INTRODUCTION

1.1 RESEARCH BACKGROUND

Majority around 80 to 85% of all recorded maritime accidents are generally attributed to human error or associated with human error. Contribution of human error to maritime accidents has increased over a ten-year period 1991 to 2001 (Baker and Seah, 2004). 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. Pomeroy and Tomlinson (2000) stated that many of the failures are actually the result of errors (i.e. latent failures) that have been designed and constructed into highly complex systems especially during system integration and interfacing. The scale of damage suffered, taken together with the implication of human error as a major cause for the accidents, has made human factors study an important area of concern globally. Many individuals and organizations are involved in marine navigation risk management framework. 80% 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.

The main focus is to enhance safety of mariner's performance through motivation, education and training, system design, and procedures and rules. The behaviours associated with the navigation process are at the lowest level and the international organizations responsible for setting laws are at the highest level. The way in which decisions of top levels influence activities of lower levels, and the feedback from lower levels to top levels, will be very important determinants of safety in marine navigation. In addition, some external dynamic forces will put pressures on the system and change the structure of the system over time (Rasmussen, 2012).

The impact of marine work environment on mariners and ships are likely to increase the possibility of error on board ship. Factors such as changes in working practice, information overload, information and equipment over-reliance, inadequate training, and fatigue have influenced some accidents at sea such as the collision between Norwegian Dream and Ever Decent (Pomeroy and Tomlinson, 2000), and the grounding of passenger ship Royal Majesty (National Transportation Safety Board, 1997). Human errors depend on the internal factors related to the operators' characteristics and differences such as skill, experience, task familiarity, etc. and the external factors to the operators such as equipment design and installation, task complexity, work environment, organizational factors, operating procedures. A proper balance between the capability of the human operator and the difficulty of the task would decrease the likelihood of human error (Whittingham, 2004).

Equipment or systems on board ship, although are well designed, will not remain safe or reliable if they are not properly maintained. The general objective of the maintenance process is to make use of the knowledge of failures and accidents to achieve the maximum possible safety with the lowest possible cost (Cicek et al, 2010). Maintenance, repair and overhaul of complex industrial and marine systems have received considerable attention in the last decades due to the high amounts of capital invested and the high availability rates requested. Especially to prevent the risky situations and to increase systems reliability on board ships, the prestigious marine engine manufacturers and ship operators have continuously analysed evidence gathered from the past experiences.

The lack of available ship as a means of transport caused by unplanned maintenance system resulted in a decrease of existing equipment performance in particular motor carrier category (treatment cannot be excluded regarded because when the process performance of a motor carrier does not do carefully, then the motor carriers will decline slowly but surely). A motor carrier in ship usually called diesel engines. Diesel engines are well known for their operational robustness and efficient performance. These attributes make them a leading choice for prime movers in critical industrial, and mobility applications. Despite the diesel engine's known reliability, there are some operational issues that justify monitoring critical engine components and subsystems in order to increase the overall availability and readiness of diesel-powered systems. Moreover, engines typically constitute a significant fraction (1/10-1/5) of the acquisition costand a comparable fraction of the life cycle cost for mobility applications, thereby providing the motivation for engine condition monitoring on the basis of reducing the total life cycle costs. Review of the available literature indicates that the fuel injection and cooling subsystems are among the most problematic on diesel engines contributing to reduced readiness and increased maintenance costs.These faults can be addressed and studied using scaled testing to build the necessary knowledge base to quickly transition the methods to full-scale, more costly diesel engines (Banks, et al 2001).

Diesel engines play major roles in automotive and stationary applications (Nunney, 1998). The life cycle cost of diesel engine is largely determined by the design phase, and its inherent reliability is also heavily influenced by this phase. In order to improve the reliability of the engine, similar diesel engine which have detailed Failure Mode and Effects Analysis (FMEA) documents are usually used as references for priority identification and risk estimation of failures model in FMEA.

FMEA is a methodology designed to identify potential failure modes for the product, to assess the risk associated with those failure modes, to rank the issues in term of importance, and to carry out corrective actions to address the most serious failure modes. Failure modes may be introduced in design, manufacture, and/or usage, and can be potential or actual. Effects analysis refers to studying the consequences of those failures. FMEA is widely used in the manufacturing industry in whole life cycle of a product (Bowles and Bonnell, 1998).

In diesel engine design and manufacturing, it is common to perform FMEA. The aim of diesel engine FMEA is to find potential failure modes and to implement design changes, to eliminate critical failure modes, and to decrease the maintenance cost when the engine is put into use.

1.2 PROBLEM STATEMENT

Analysis of the cause of accidents involving complex technological systems clearly indicates that a small percentage of the major accidents are caused by failures of the systems something less than 20%. Rather, the accidents caused by unanticipated actions of people have undesirable outcomes something more than 80 %. These an unanticipated actions and outcomes can have root source in design, construction, operation, and maintenance.

Perrow (1999) states that the error inducing character of the system in shipping lies in the social organization of the personnel onboard, economic pressure, the structure of industry and insurance and difficulties in international regulation. This review examines the current status of safety in the maritime industry and the human factors that may contribute to the causal chain in shipping accidents. There is a particular combination of demand characteristic of the maritime industry such as fatigue, stress, work pressure, communication, environmental factors, and long periods of time away from home, which could be potential contributors. Exemplifying that in shipping "there are a number of workplace dangers in combination, something rare in other industries" (McNamara, et al, 2000).

Maintenance, repair, and overhaul of complex industrial and marine systems have received considerable attention in the last decades, due to the high amounts of capital invested and the high availability rates requested. Especially to prevent the risky situations and to increase systems reliability onboard ships, the prestigious marine engine manufacturers and ship operators have continuously study evidence gathered from the past experiences.

Current methods used to assess system reliability are focused primarily on the hardware component of the system. At one end of the spectrum are the qualitative methods that use historical and experimental hardware fail data to predict future failure rates and how various hardware can fail by using FMEA. By using FMEA, we can identify where and how it might fail human factor tabulation data, assessing the relative impact of different failures, and identifying the parts of the process most in need of improvement using factor analysis. We can make the worksheet data after determining the failure mode based on the validation matrix.

In this paper, the ship has an important role in the shipping industry, and the analysis of engine system service is needed. This is done to prevent the failure of components within the system that can cause a failure of the punitive damage portion of the ship's functions that will ultimately lead to decreased safety level and can endanger passengers and cargo transported even to ships nearby. Bad fuel distribution system on a ship causes a breakdown in the fuel to the main engines. This results in a delay in the ship's anchor and needs regular care, which is potential for disrupting the fuel distribution system. A technique used to identify, prioritize and eliminate potential failure in systems is used for reviewing a process or operation in which is systematically acquainted with FMEA. FMEA is used as a risk assessment technique which synthesizes failure modes in order to identify early response and to take appropriate actions into account. As a case application, crucial troubles in fuel oil systems onboard ship are investigated deeply to adopt an effective preventive maintenance strategy for fuel oil system in marine diesel engine.

1.3 RESEARCH OBJECTIVES

This study embarks on the following objectives:

i. To analyse sea transportation cause factors occurring in Indonesia from year 2005 to 2010.
ii. To develop FMEA database especially in marine diesel engines.
iii. To propose navigation system improvement in marine diesel engines initiative to reduce accident occurrence based on future analysis outcome.

1.4 RESEARCH QUESTIONS

The purpose of the study is outlined in the following research questions:

i. What are the causes of Indonesian Ship Accident from 2005-2010?
ii. What are the potential failure mode for the element of marine diesel engine?
iii. What is the appropriate recommendation for improving the navigation system in marine diesel engine to reduce the occurrence of accident?

1.5 STUDY JUSTIFICATION

This study investigates many accidents occurred in Indonesia, especially in sea, rivers, lakes, and crossing. It takes a long time to know the damage on each of the components of the operated ship. It is because damage on one component will cause greater damage on the function of a ship. Therefore, it is important to look for the potential failure mode using the FMEA approach.

There are many types of ship accident, like sunk, collision, grounded and fired. However, only fired ship could be use with the FMEA. Every year more and more ships are lost through fire and collision. Fired ship alone, however, results in more total losses of ships than any other form of casualty. The most common causes of shipboard fire are the most obvious: maintenance burning and welding are responsible for nearly 40 per cent of all outbreaks (Pomonsky, 2012). Smoking leads to countless fires that break out when no one expects. Lack of attention, spontaneous combustion and electrical faults are the major causes. The engine room is at special risk from flashbacks in oil fired boilers, leaky piping carrying oil, overheated bearings and even the accumulation of rubbish for example oil rags, dirty oil, tins of oil, etc.

Fired ship happens because of element of the system and usually in this case the ship that use the diesel engine. The causes of engine room fires can usually be traced back to a lack of maintenance or bad watch keeping practices. They are usually caused by fuel spills, overheating components or careless use of electric welding or gas heating gear. The fuel system is one of the supporting system of main drive system of a ship. The fuel system functions to supply fuel from the storage tank to the main engines. As there are a lot of systems aboard the ship, this potential failure study is limited for the element of marine diesel engine system mainly into: fuel oil system, lubricating oil system, water cooling system and starting oil system. Through this study, we can identify the potential failure in that such systems and we can define the effect of the Main Engine that are critical and also the type of its severity class. This severity class describes potential hazards identified with regards of the ship operation.

The reason for using the FMEA methodology is because it is a rather simple technique. The failure modes of each component in a given system are listed in a table, and the effect of that failure is postulated and documented. The method is systematic, effective, and detailed, although sometimes time-consuming and repetitive. The reason the method is so effective is that every failure mode of every single component is carefully examined. FMEA method can identify potential failure modes within a system, subsystem or component. It can also prioritize potential failures in all modes for determining and deciding proper actions to prevent or reduce the likelihood of occurrence of each failure in the future. FMEA techniques are applied to analyze the possibility of failure, with the purpose to increase the safety factor and in the end to achieve higher customer satisfaction.

One main difference between FMEA method and other methods of quality is that the FMEA method is active, while the other is passive method (based on reaction) when a failure occurs. The other methods define some of the reactions, but the reaction will take alot of cost, time and resources. While FMEA tries to estimate the potential issues and risks and then decides on measures to reduce or eliminate those risks.

1.6 SCOPE AND LIMITATIONS

This study was conducted in Jakarta, Indonesia with reference to the secondary data of ship accident in the last 5 years from 2005-2010. The data obtained are primary data by Komite Nasional Keselamatan Transportasi/KNKT (Safety Transportation National Committee) and Mahkamah Pelayaran (Marine Court). For the FMEA data, the data were collected from the ship diesel engine and for the failure on:

i. Fuel Oil System
ii. Lubricating Oil System
iii. Water Cooling System
iv. Starting Air System

1.7 ORGANIZATION OF THESIS

The current chapter (Chapter 1) presents a framework for the research undertaking, providing a background, problem statement, objectives, scope and limitations of this thesis.

Chapter 2 presents an overview of literature relating to ship accidents in Indonesia, characteristic of sea transportation accidents, the theory of Formal Safety Assessment (FSA), FMEA, and diesel engines description.

Chapter3 , explores the research methodology, types of study and data collection, safety of ship, ranking criteria when using the FMEA Method and also FMEA application for marine diesel engine.

Chapter 4, findings of study undertaken, explains the accident data, the table and result of the FMEA analysis.

In chapter 5, the report concludes with a summary of the researchand discusses the contribution of the thesis. It finally describes the purpose of navigation system improvement in marine engines.