Chapter 59
Using AIS Data for Navigational Risk Assessment in Restricted Waters

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ABSTRACT

The Strait of Malacca is one of the most important shipping lanes in the world. It averages 150 ship passes a day and more than 50,000 ships annually. With a high concentration of vessels in a narrow path, multiple risk situations arise. Analyzing traffic density is made harder by cross traffic and an unknown traffic density at the Strait. In 2009, Universiti Teknologi Malaysia (UTM), through a collaboration with Kobe University, successfully installed an Automatic Identification System (AIS) receiver. Through the AIS receiver, data of ship movements in the Strait of Malacca and Singapore could be recorded. A program was established by UTM to retrieve the data for the purpose of marine traffic collision risk analysis. In this research, a risk assessment method using AIS data is proposed for restricted waters such as for the Strait of Malacca and Singapore. The Risk Assessment Methodology requires the estimation of collision probabilities. The collision probability of the proposed method considers the Traffic Density, directions of traffic flow (with respect to a subject vessel), and probability of navigational failure. An area in the Strait of Singapore between the latitudes of 1°13'N and 1°07'N and Longitudes of 103°4'E and 103°56'E was selected to illustrate the method. By analysing the AIS data of traffic flow, the probabilities of collision for the area were determined. The effect of vessel parameters of length and speed on the risks of collision are also shown.

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INTRODUCTION

The Straits of Malacca and Singapore is one of the most important shipping channels in the world connecting the Indian Ocean with the South China Sea and the Pacific Ocean. The straits remain as one of the most important shipping lanes in the world with an average of 150 ships passes a day and more than 50,000 ships annually.

With high concentration of vessels in a narrow path, multiple risks situation arises. Analyzing traffic density is made harder with many cross traffic and the unknown traffic density at Strait of Malacca.

Over the past 30 years, several managerial and navigational solutions have been implemented in the Straits to enhance navigational safety. Since 1st May 1981, Traffic Separation Scheme (TSS) has been established to separate the opposing stream of traffic into different traffic lanes.

A guide to passage planning was compiled and published by the Society of International Gas Tanker and Terminal Operators Ltd (SIGTTO) in 2000 concerning the safety of navigation through the Straits of Malacca and Singapore due to a growing number of near miss reports.

In 2000, the International Maritime Organization (IMO) introduced the mandatory carriage of Automatic Identification System (AIS) for merchant vessels in an amendment to the SOLAS convention, coming into force by 31 December 2004. The regulation makes AIS mandatory for all merchant ships of 3000 Gross Tonnage (GT) engaged on international voyages, cargo ships of 500 GT and upwards not engaged on international voyages and all passenger ships, irrespective of size.

A new possibility of data acquisition was introduced with the introduction of AIS. Since AIS has been widely applied and able to transmit data of vessels on position, speed, and course, it is possible to conduct investigation on the behaviour of vessel manoeuvring and navigational risk throughout her voyage.

In 2009, Universiti Teknologi Malaysia (UTM) through collaboration with Kobe University had successfully installed an Automatic Identification System (AIS) receiver. Through the AIS receiver, data of ship movements in the Straits of Malacca and Singapore within its range could be recorded.

The data recorded remains raw or un-processed and certainly an appropriate data sorting technique is required to gain benefit of the information gathered. A user friendly program was established to process and publish the data which will allow users to retrieve the required information for further applied in marine traffic risk analysis.

As a case study, the authors used AIS data in the Traffic Separation Scheme (TSS) of Straits of Malacca and Singapore and produce a statistical analysis of the marine traffic. The statistics include number of vessels, traffic density, and direction of traffic flow. A method to estimate the probability of collision from AIS data was presented. To assess the collision risk, a simplified procedure for qualitative evaluation of risk is proposed.

BACKGROUND

It is well know that risk is a concept consisting of the probability of occurrence and consequences of an undesired event. The risk is commonly assessed as the product of the probability of occurrence of an undesired event and the expected consequences.

At present, collision probability of vessels is commonly expressed based on study of Fujii and Shiobara (1971) where the number of collision occurrences over the studied time period, N_{coll} is estimated as

$$N_{coll} = N_A P_c \quad (1)$$

where N_A refer to number of vessel encounter in a time period or number of collision candidates and P_c is the probability of failing to avoid a collision when the vessel on a collision course due