Risk analysis for RoPax vessels: A case of study for the Strait of Gibraltar

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A B S T R A C T

The Strait of Gibraltar (SOG) is one of the principal navigation areas in the world. The maritime traffic registered in the area is approximately 110,000 ship movements per year, where thirty-three per cent of total traffic involves roll on/roll off passenger (RoPax) ships which run scheduled voyages between ports in the area. There are presently many accidents involving this type of ship being reported. Although these incidents have serious consequences, both based on a financial scale and regarding human safety, there is no formal maritime risk analysis study for this area carried out to date. The aim of this paper is to present the results of a risk analysis for RoPax ships operating in the SOG, based on accidents statistics covering the period 2000–2011. The work has been performed using the two first steps of the IMO Formal Safety Assessment methodology: Hazard Identification and Risk Analysis. To identify the hazards and their associated scenarios and quantify, their frequencies and consequences, the Historical Accident Data Analysis and Expert Judgement techniques were used. A risk matrix has been drawn up to calculate the risk indices of the identified hazards. A comparative study of the accident frequencies obtained from similar previous studies is also presented in the paper. A high-level model risk for collisions was established through the elaboration and quantification of an Event Tree, calculating the individual and social risks. The conclusions of this study could serve as recommendations to be used in a subsequent decision making process.

1. Introduction

Ships designed to carry passengers and roll on/roll off cargo (RoPax ships) are among functional types of ships. The flexibility, ability to integrate with other transport systems and operating speed, has become extremely popular in many routes. However, as past accident statistics demonstrate, there are numerous examples of accidents involving RoPax ships. Consequences of these accidents include large numbers of lost lives, serious damage to the environment and economic costs. The capsize of the Herald of Free Enterprise in 1987, the fire of onboard the Scandinavian Star in 1990 and the sinking of the Estonia in 1994, are notable cases of well-known and investigated maritime casualties. Unfortunately, major maritime disasters involving RoPax ships still occurring in the last decade, as the sinking of the ferry Al Salam Boccaccio 98 in February 2006, and more recently the sinking of Sewol in April 2014.

Studies relating to shipping risk assessment have received growing interest in the last years. Risk assessment has been very helpful for the review and development of new rules and regulations in order to reduce accidents and improve maritime safety. Many methods and applications for maritime transportation risk analysis have been presented in the literature. Goerlandt and Montewka (2015) present a complete review of scientific approaches to risk analysis focusing on applications addressing accidental risk of shipping in a sea area. The review covers the period from 1970 to 2014, up to a total of 58 applications.

A number of risk assessments studies applied to RoPax ships can be found in the literature. Det Norske Veritas (DNV, 1996) carried out a study on RoPax ships sailing in the North West of Europe; focusing on the investigation of operational dangers and causes of such vessels and quantify, when possible, their frequency and consequences through the creation of a risk model based on Event Trees (ET). Van Dorp et al. (2001) and Merrick et al. (2003) carried out both risk assessments on ferries at specific geographical areas, Washington state and San Francisco Bay, respectively. Otto et al. (2002) submitted a risk analysis for these ships to study the damages produced from collision and grounding. At the same time, the International Maritime Organization (IMO) adopted in 2002, the Formal Safety Assessment (IMO, 2002); a structured and systematic methodology, aimed to increase maritime safety based on risk analysis. Accordingly, we can find studies as the hazard identification related to casualties of RoPax vessels (Antao and Soares, 2006) which used the FSA methodology. Another risk analysis study for the...
To assess the safety level of RoPax shipping in the SOG, the study identified a number of hazards and their associated scenarios. These were used to calculate the rates and levels of risk resulting from open sea collisions involving RoPax ships. The study also focused on drawing the taxonomy and distribution of maritime emergencies in the area.

The Strait of Gibraltar is one of the main shipping areas in the world, with a high volume of maritime traffic. The aim of this study is to carry out a risk analysis for RoPax ships in the area. The work has been performed in accordance with the IMO FSA guidelines. The first objective consists of identifying the hazards and associated scenarios and quantifying, to the extent possible, their frequencies and consequences. In order to do this, the Historical Accident Data Analysis and Expert Judgement techniques were used. A risk matrix has been drawn up which is supported by the opinion of experts in order to calculate the rates and levels of risk. Also, a high-level model risk for collisions will be established through the elaboration and quantification of an ET. It is used to determine the safety level of RoPax calculating the individual and social risks. A study of the accident frequencies obtained from similar previous studies has also been carried out. Finally, the conclusions of this study could serve as recommendations for a subsequent decision making process.

2. Methodology

2.1. Approach adopted

The FSA, adopted by the International Maritime Organization (IMO) in 2002, is a structured and systematic methodology, aimed at enhancing maritime safety. This includes the protection of life, health, property, and the marine environment, by using risk analysis and cost benefit assessment. The last update of the FSA guidelines was in 2012 (IMO, 2012).

FSA consists of five steps as follow:

1. Identification of hazards
2. Risk analysis
3. Risk control options
4. Cost-benefit assessment, and
5. Recommendations for decision-making

This paper is focused in the step 1: hazard identification and step 2: risk analysis.
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