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ScienceDirect

Procedia Engineering 194 (2017) 298 – 306

Procedia Engineering

www.elsevier.com/locate/procedia

10th International Conference on Marine Technology, MARTEC 2016

# A Study on Accident Theories and Application to Maritime Accidents

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**Abstract**

Maritime accidents, when taking place, often affect in large scale over the environment, society and economy. Many such accidents have occurred in the past century. In this study, it is observed that the traditional approach towards maritime safety, in general, is reactive. It indicates that accidents are unpredictable, and this is the most fundamental problem in safety science. In this connection, a review on some notable accident theories/models was conducted where the attributes of different accident theories/models were compared. The literature review suggests that over the years accident theories/models have been originated from different disciplines and the theories/models have been evolving with the changes in the society. The study reveals that maritime accidents take place in a complex socio-technical context. In such accidents, a single root cause may be traced back in the cause-effect chain, but it is not enough for preventing similar accidents in the future. The accident of Titanic (1912) and the accident of Costa Concordia (2012) justify this argument. Therefore, the paper discusses the development and usage of a new technique, such as Logic Programming Technique (LPT), for analyzing and understanding accidents. From an engineering point of view, the study concludes that accidents may be treated as a system control problem and modern innovative technologies like LPT may be further developed and utilized in this regard.



Peer-review under responsibility of the organizing committee of the 10th International Conference on Marine Technology.

*Keywords:* Safety science; accident theory; accident model; maritime safety; Logic Programming Technique (LPT)

## 1. Introduction

Maritime accidents have shocked the world every now and then. Historically, the list of maritime accidents is quite long and extensive, and the number of casualties is grievously high. There are specific accidents, which essentially reshaped the maritime industry. These accidents occurred over the last one hundred years and forced the maritime community to reach international agreements on safety, liability, and environmental protections. A timeline produced by Awal [1] is shown in Fig. 1 which can be considered in this regard. The figure chronologically shows the notable maritime accidents that occurred over the past century and the necessary measures taken thereafter.

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Peer-review under responsibility of the organizing committee of the 10th International Conference on Marine Technology.
doi:10.1016/j.proeng.2017.08.149

Perhaps, the most famous accident of all is the sinking of Titanic, which struck the first blow for real international cooperation on safety regulations, known as the International Convention for the Safety of Life at Sea (SOLAS). In 1914 two years after the Titanic tragedy, SOLAS was adopted. The 1934 sinking of the Morro Castle off the New Jersey coast, which went up in flames, led to new fire suppression, protection and control regulations and equipment requirements as a significant upgrade to SOLAS. The Torrey Canyon oil spill off French and Cornish coasts in 1967 led to the International Convention for the Prevention of Pollution from ships (MARPOL) in 1973. On March 16, 1978, the Amoco Cadiz tanker ran aground three miles from the coast of Brittany, France due to a steering gear failure. It split into three before sinking, creating the largest oil spill of its kind in history to that date, more than one and half a million barrels. Public outcry and political pressure resulted in significant updates to both MARPOL and SOLAS, and the addition of safety and pollution audits that led to 1982 Paris Memorandum of Understanding (Paris MoU), which established Port State Control. The significance of port state control is that it enabled an international port inspection system that makes it impossible for non-compliant ships to hide [2].

The remarkable capsizing of the Herald of Free Enterprise in 1987 took place minutes after leaving the harbor in Zeebrugge, Belgium. Incredibly, the bow door was left open, resulted in the loss of one hundred ninety three out of the five hundred and thirty nine passengers and crew. This accident led to adoption of International Safety Management (ISM) Code. This code is designed to prevent damage to life and the environment at sea, by requiring each vessel to have a working, audited, Safety Management System (SMS). It also required shipping companies to have a license to operate [2].

In recent times, several accidents have shocked the world as well. The accident of MV Costa Concordia and accident of MV Sewol are mentionable in this regard. On January 13th, 2012 the Italian cruise ship Costa Concordia listed after striking an underwater rock obstruction off Isola del Giglio, Italy. Thirty-two people lost their lives. The accident of MV Sewol in 2014 shocked the world when she capsized while carrying four hundred and seventy-six lives, and most of them were secondary school students. The sinking of MV Sewol resulted in widespread social

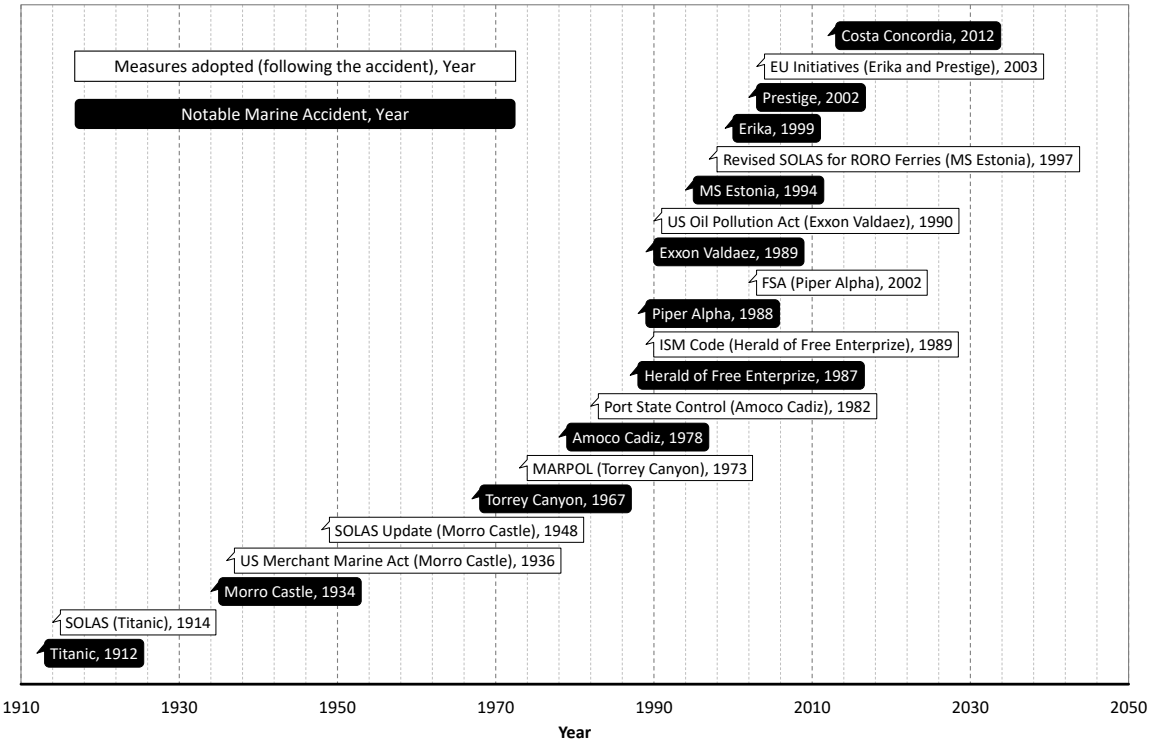


Fig. 1. A timeline of notable maritime accidents and reactive measures taken by international communities [1].