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Usability of accident and incident reports for evidence-based risk modeling – A case study on ship grounding reports

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ABSTRACT

This paper presents study of 115 grounding accident reports from the Safety Investigation Authority of Finland and Marine Accident Investigation Branch of the UK, as well as 163 near-miss grounding reports from ForeSea and Finnpilot incident databases. The objective was to find the type of knowledge that can be extracted from such sources and discuss the usability of accident and incident reports for evidence-based risk modeling. A new version of Human Factors Analysis and Classification System (HFACS) is introduced as a framework to review the accident reports. The new positive taxonomy as Safety Factors, which are based on high level positive functions that are prerequisite for safe transport operations, is used for reviewing the incident reports. Accident reports are shown as a reliable source of evidence to extract the most significant contributing factors in the events. Mandatory incident reports are considered useful for understanding the effective barriers as risk control measures. Voluntary incident reports, though, are seen as not very reliable in their current form to be used for evidence-based risk modeling.

1. Introduction

Risk models are developed for understanding the behavior of a system and its components in order to mitigate the involved risks by implementing proper control measures (IMO, 2002). In this regard, a suitable model for risk management purposes should reflect the available background knowledge on the system and its components (Aven, 2013; Montewka et al., 2014). Here the term "knowledge" is used as "know-how" (Ackoff, 1989), which in risk management concept could mean "know how to control the risk". Most of the available risk models for maritime risk analysis are focusing on giving risk figures rather than presenting the available background knowledge of the system (Goerlandt and Kujala, 2014). The models are mostly based on the intuition of the developers rather than the evidence, thus they may not be proper enough for risk management purposes; for a thorough discussion on this subject the reader is referred to Mazaheri et al. (2014b). Lack of background knowledge about the underlying causes of a system or improper presentation of the available background knowledge leads to uncertainty in the used risk models (Aven and Zio, 2011). Therefore, evidence-based risk modeling that addresses real accident scenarios as opposed to imaginary scenarios is encouraged (IMO, 2002, 2012; Kristiansen, 2010; Mazaheri et al., 2013b, 2014b).

One of the main sources of the evidence that is available and can be used for evidence-based risk modeling is accident reports that are prepared by expert accident investigators (Schröder-Hinrichs et al., 2011). Since obtaining primary data about an accident that has happened in the past is nearly impossible, using accident reports as a secondary source of data is unavoidable (Mazaheri et al., 2013b); see Fig. 1. However, there are some concerns regarding using only accident reports for modeling. One is that the accidents are scarce in frequency, thus the number of scenarios that can be analyzed is limited (Ladan and Hänninen, 2012). To overcome this imperfection, one of the suggested solutions is to utilize incident reports (Rothblum et al., 2002), as incidents occur much more frequently than accidents (Bole et al., 1987). Besides, since incidents are governed by the similar mechanism and underlying factors that cause accidents (Harrald et al., 1998) but they did not end in actual accidents, analyzing the incidents may likely give insights about the in-placed risk control options that stopped the incident to become an accident. Here, an incident or near-miss refers to an individual or a series of mishaps that did not result in a serious accident like ship grounding with consequences on human life or the environment.

By virtue of the above statement, utilizing accident and incident reports may be beneficial for evidence-based risk modeling. This is because accident and incident reports can be useful for uncovering the factors that have contributed to the occurrence of a mishap as well as for evaluating the level of importance of each factor.

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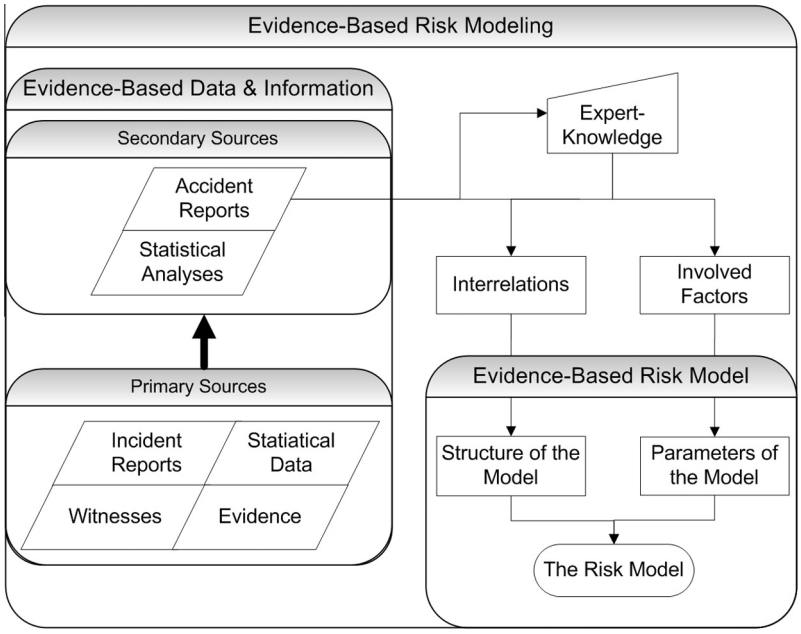

Fig. 1. Framework for evidence-based risk modeling.

Besides, the way that the contributing factors are linked together may be understood from such reports. In this regard, the aim of this paper is to study the usability of accident and incident reports for evidence-based risk modeling by assessing the type of knowledge that one can extract from such reports. For this study, we have used ship grounding related reports due to high frequency that this type of accident has in local and global perspectives (Kujala et al., 2009; Samuelides et al., 2009). This makes the reports of grounding accidents and incidents to be more easily available in compare with other types of accidents. Besides, the importance of this type of maritime accident with regard to its consequences (Hänninen et al., 2014; Mazaheri et al., 2014b) makes this type of accident worth to study.

As Lundberg et al. (2009) highlighted, in practice the result of an accident analysis depends on two issues namely the causes and the causality. The causes are the contributing factors that their presence in the accident is observed, and the causality is related to the mechanism that the causes are interconnected and cause the accident at the end. In this paper, we merely look for the presence of different causes in the causal networks of grounding accidents based on the reviewed reports, and the causality relation analysis is left for further studies. In other words, we only searched for the most important nodes that can later be present in a probabilistic causal risk model of an accident like Bayesian Belief Networks (Pearl, 1988; Hänninen, 2014) (i.e. Parameters of the Model in Fig. 1) and only used that to support our discussion.

The remainder of this paper is organized as follows: the accident and incident reports that are used for the study are introduced in the next Chapter. The applied methodologies for reviewing the reports are presented in Chapter 3. The results of the study are presented in Chapter 4, followed by a discussion in Chapter 5. The paper is concluded in Chapter 6.

2. Accident and incident reports as data sources

2.1. Accident reports

Accident reports are categorized as a secondary source of data, in which the reports are prepared from the primary data that the investigator obtained first-hand by interviewing the operators and analyzing the evidence, normally short time after an accident (Mazaheri et al., 2013b). In maritime safety analysis, the official accident reports that are prepared by the accident investigation boards usually present valuable information regarding why and how an accident happens. For this study, we have utilized 73 grounding accident reports from the Safety Investigation Authority of Finland (SIAF) and 42 reports from the Marine Accident Investigation Branch (MAIB) of the UK, which both of the sources are freely accessible for the public.

Although more systematic analysis and attention toward the organizational contribution factors can be seen in the recent reports of SIAF, the structures of the reports are more or less the same. They are all started with a summary, which briefly explains the event and the findings of the investigators. The reports continue with general description of the vessel, external condition at the time of the accident, and then the accident and the possible performed rescue operations. These are followed by the analysis of the accident and the causes. At the end, the reports are mostly concluded by presenting the causal chain of events and the underlying factors in the accident, as well as some recommendations to improve maritime safety. The parts that are fully reviewed for this study are *summaries*, *analyses*, and the *conclusions*. However, for some of the reports, other parts are also browsed in order to better understand the accident and the connection of the causal events.

Almost the same approach and structure was taken by MAIB. The reports started with synopsis of the event and the factual information about the accident. They are continued with analysis of the accident and conclusion of the analysis. Then the performed actions by different organizations following the accident are presented and the final recommendation by the investigators concludes the reports. The parts in MAIB reports that are fully reviewed for this study are *synopsis*, *analysis*, and *conclusion*.

2.2. Incident reports

On the contrary to the accidents, there is almost no available systematic reporting system for incidents. Currently, there are quite few available sources that can be used for obtaining the near-miss data, of which not all are available for public use; for a