A text-based approach for identification of RIFs in Arctic shipping

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ABSTRACT

The opening of the Arctic sea routes attracts global attention. Identifying the risk influencing factors (RIFs) is critical for proposing target risk control options (RCOs) in Arctic shipping. This paper presents a text-based approach to identify critical RIFs using multi-source data, including maritime accident investigation reports and literature. A mapping model is proposed for interpreting the relationship between the identified critical RIFs and the associated accident scenarios, such as collision, grounding, and ship-ice/iceberg collision. The results show that wind, visibility, drift ice, ridge ice/iceberg, ship speed, and communication equipment failure are mutual factors that induce various maritime accidents in Arctic shipping.

KEY WORDS: Marine safety; Arctic shipping; risk influencing factor; maritime accident investigation report; text mining

INTRODUCTION

In recent years, with global warming and the diminishing extent of Arctic sea ice, the conditions for transportation activities of Arctic shipping have been greatly improved and the volume of ship traffic has increased rapidly. This has increased the happening of maritime accidents in Arctic shipping. According to the Safety and Shipping Review issued by AGCS in 2021, there were 520 ship navigation accidents that occurred in Arctic waters from 2011 to 2020. Maritime accidents may severely restrict the development of the Arctic sea routes. Therefore, it is significant for risk analysis of ship operations in ice-cover waters and proposing associated risk control options (RCOs) for reducing maritime accidents in Arctic shipping.

RIFs analysis is a critical issue for risk management in Arctic shipping. Khan et al. (2018; 2020) and Obisesan et al. (2018) extracted the RIFs of ship-ice collision accidents in the Arctic waters from three aspects of environmental factors, ship-related factors and human factors. Aziz et al. (2019) established a structured bow-tie model to assess the risk of fire/explosion and machinery damage under the influences of ship failure and human error. Zhang et al. (2019) considered the impact of the environment on personnel and identified human factors in collision accidents between assisted ships and icebreakers. Afenyo et al. (2017) established a ship-iceberg collision accident model to derive the main factors causing the collision. Fu et al. (2016; 2018) proposed a multi-factor coupling model based on the ship stuck in ice. Kum et al. (2015) sorted out the root causes of ship accidents in Arctic waters and established a fault tree model for ship collision and grounding accidents.

The above studies have conducted a relatively comprehensive identification of RIFs in Arctic shipping under a single accident scenario. However, there is a lack of research on the complex coupling relationship between multiple accident scenarios and the RIFs. Because of this, this paper proposes a text-based approach to identify the critical RIFs that induce maritime accidents in Arctic waters and obtain the relationship between these factors and accident scenarios (e.g., collision, grounding, ship stuck in ice, ship-ice/iceberg), based on maritime accident investigation reports (MAIRs) and the related literature.

The rest of this paper is organized as follows. Section 2 introduces the text-based approach for identifying the RIFs in Arctic shipping. Section 3 gives a brief overview of the data source. Section 4 presents an application of the proposed method through a case study that uses MAIRs and literature mentioned in Section 2 and discusses the relationship between RIFs and accident scenarios in Arctic shipping. Finally, section 5 summarizes this study and proposes relevant conclusions.

METHOD

A test-based approach is used to identify the RIFs that induce maritime accidents and express the mapping relationship between RIFs and multiple maritime accidents in Arctic shipping, based on MAIRs in Arctic waters and literature related to risk management of Arctic shipping. The specific research steps are shown in Fig.1.

Step 1: Data collection. The data used for the identification of the RIFs in Arctic shipping are acquired from the global MAIRs in Arctic waters and related literature.

Step 2: Identification of RIFs. Based on the collected MAIRs and literature in Step 1, the potential RIFs are identified by an in-depth analysis of these text documents from environmental, ship-related, human and organizational aspects. Then, the critical RIFs are selected by statistical analysis of the frequency of the potential RIFs involved in the MAIRs and literature.