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Port safety evaluation from a captain's perspective: The Korean experience

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ABSTRACT

There are many factors affecting navigational safety in ports, including weather, the characteristics of the channels and vessel types, etc. This paper aims to identify the factors influencing navigational safety in ports and to analyze the extent to which such factors affect the safety of ports from the perspective of ship captains through a real case study. A quantitative analysis is carried out using the data collected from 21 captains who have over 10 years experience in operating ships individually. The identified factors indicate risk implications in ports. A fuzzy analytical hierarchy process is used to evaluate the importance of the factors and to rank the safety levels of the targeted ports in Korea from a captain's perspective. Consequently, among Busan, Ulsan, Gwangyang, Incheon, and Mokpo, Busan is evaluated by captains as the safest port, while Mokpo is the most risky. The research also reveals that it is applicable to use domain expert knowledge when historical failure data is unavailable or difficult to access to evaluate port safety. The result shows great research significance in terms of providing relevant stakeholders, such as port authorities and shipping companies, with an insight into port safety performance and thus facilitating the development of the associated risk control measures.

1. Introduction

Catastrophic maritime accidents still occur as demonstrated by the Costa Concordia accident despite great efforts to reduce their likelihood and consequences. Vessels are gradually increasing in size and speed, as well as being involved in higher traffic volumes, particularly in narrowing waters, such as ports (Liu et al., 2005). Consequently, marine accidents happen more likely in such waters causing extensive loss of lives, damage to vessels and cargo, and serious marine pollution. Regarding the marine pollution, Cho (2007) stated that the maritime accidents caused serious marine pollution over a large area of southern coastal water in Korea as well as damage to the fisheries.

The fact that Korea is surrounded by water has contributed to the development of its international trade. This has led to an increase of maritime traffic in ports and their associated narrow waters, which will affect port and maritime navigational safety. Evidence shows that among 882 marine accidents occurred from 2002 to 2008 in Korean waters, approximately one-fifth occurred in ports (Korea Coast Guard, 2008). It is therefore urgent to identify the factors influencing port safety and evaluate the navigational safety levels of Korean ports.

There are many factors that can cause the occurrence of the accidents in ports. Different stakeholders may have different concerns regarding such factors. This study mainly focuses on the captains' perception in order to identify the factors that can affect port navigational safety and analyze their influence using a fuzzy analytical hierarchy process (AHP). This paper applies a fuzzy AHP approach to overcome the difficulties involved in collecting historical data and quantifying experts' knowledge, experience, and conceptions. Pan (2008) stated that fuzzy AHP is a method capable of handling the inherent subjectivity and ambiguity involved in identifying perceptions in order to extract numbers. In this study, a questionnaire is designed and used to collect the required data from captains with more than 10 years experience in moving ships in Korean ports. To effectively collect the captains' judgments, linguistic terms are often be used. One realistic way to model linguistic terms is to use fuzzy set theory (Yang et al., 2011, 2012). In terms of the identification of major influencing factors,

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pairwise comparisons through an AHP approach are conducted to measure the importance of the influence factors (Promentilla et al., 2006). Combining fuzzy logic and AHP enables the evaluation of Korean port safety from a captain's perspective in a situation in which uncertainty in data is high.

In-depth interviews with experienced captains, together with a careful literature review, were carried out to identify the factors that affect port navigational safety in Korean ports. To evaluate the weights of the factors and the safety level of Korean ports, 21 experienced captains (who were carefully selected based on the navigational experience in Korean ports through Korean Maritime Pilot Association) provided their judgments via a designed questionnaire. Top five ports were selected in this study according to their traffic volume from 2000 to 2012. This paper is composed with five sections. A literature review on the issues of port safety and the safety factors relating to ports is presented in Section 2. Section 3 presents the methodology including the process of selecting port safety factors and the targeted ports, as well as the fuzzy AHP method. Section 4 describes an empirical study, including a questionnaire analysis, applying fuzzy AHP to the targeted ports, as well as a sensitivity analysis to validate the results. Finally, the conclusions and implications are given in Section 5.

2. Literature review

There are no lack of studies conducted to reduce risks and extract the safety factors related to maritime traffic in ports. Fabiano et al. (2010) evaluated port safety in terms of the effect of containerization. Kaplan and Kite-Powell (2000) examined the impact of fisheries' operations on safety at sea and the use of fishermen's opinions in the safety regulation and management process. Yip (2008) conducted a study on historical accidents in Hong Kong ports, and it was shown that port traffic risks follow a particular pattern and that collision is the most common accident when traffic is heavy. Hu et al. (2008) analyzed the risks related to the vessel traffic system at sea and developed a new method to establish safe ship operations.

Hazardous event evaluation was studied in terms of toxicity, reactivity, flammability, and the risk potential of handling chemicals by Rao and Raghavan (1996). All accidents in the Gulf of Finland were analyzed in terms of vessel and accident types, and the accident statistics were presented in the last 10 years (Kujala et al., 2009).

Jalonen and Salmi (2009) mentioned that factors in marine accidents include heavy storms, natural catastrophes, wind, current, etc., according to the marine accident database. These factors are external factors. An individual ship risk factor was shown using a fuzzy approach (Balmat et al., 2009), and ship capacity, ship history, and ship parameters (flag, year of construction, gross tonnage, number of companies, and duration of detention) were considered in the statistical risk evaluation. Also, Balmat et al. (2009) addressed the fact that weather conditions, such as wind speed, sea state, and visibility, were defined as a dynamic risk factor. Sage (2005) proposed the criteria used to monitor High Risk Vessels (HRVs) in coastal waters, and the criteria related to the ships, namely dynamic factors, such as the weather, sea, or traffic conditions, and the environmental sensitivity of the sea areas in which the ships are sailing.

Darbra and Casal (2004) suggested that the specific causes of accidents in seaports could be dividing into four types: (1) impacts (ship/land effects, ship/ship effects, general operations, heavy objects, rail accidents, high winds, and other causes), (2) mechanical errors (valve failures, flange coupling failures, metallurgy failures, hose failures, high winds, over pressure, and other causes), (3) human errors (general operation overfilling, maintenance, procedures, ship/land impacts, and other causes), and (4) external causes (high winds, sabotage, external fires, ship/land impacts, ship/ship impacts, and other causes).

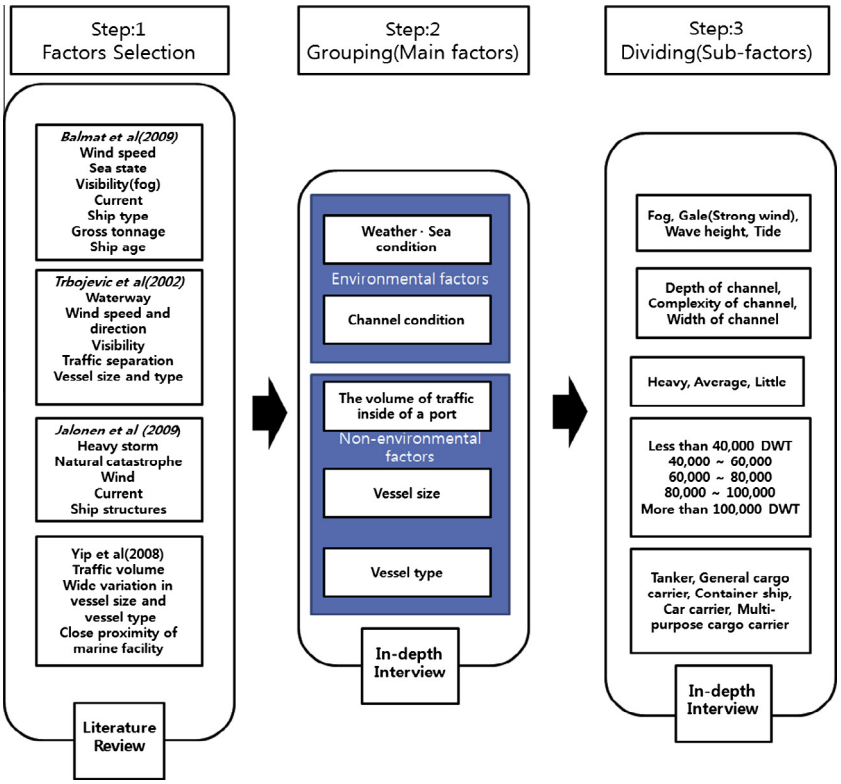

Fig. 1. Decision progress to select port safety factors.