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Investigation of shipping accident injury severity and mortality

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ABSTRACT

Shipping movements are operated in a complex and high-risk environment. Fatal shipping accidents are the nightmares of seafarers. With ten years' worldwide ship accident data, this study develops a binary logistic regression model and a zero-truncated binomial regression model to predict the probability of fatal shipping accidents and corresponding mortalities. The model results show that both the probability of fatal accidents and mortalities are greater for collision, fire/explosion, contact, grounding, sinking accidents occurred in adverse weather conditions and darkness conditions. Sinking has the largest effects on the increment of fatal accident probability and mortalities. The results also show that the bigger number of mortalities is associated with shipping accidents occurred far away from the coastal area/harbor/port. In addition, cruise ships are found to have more mortalities than non-cruise ships. The results of this study are beneficial for policy-makers in proposing efficient strategies to prevent fatal shipping accidents.

1. Introduction

The shipping industry has witnessed a rapid growth in the last three decades because of the significant increase in transportation demands. Shipping movements are operated in complex and high-risk environments, and many shipping accidents occur at seas as well as in restricted waters (Akten, 2004). The seriousness of ship accidents might be influenced by various factors such as collision, contact, fire/explosion, grounding, material/hull damage, sinking, darkness and adverse weather conditions.

More and more shipping liners have shown an increasing interest in using large-sized ships for the foreseeable future because of their scale advantages. However, a large ship has reduced maneuverability, which ultimately increases its accident risk (Chapman and Akten, 1998). Since a bigger size generates a corresponding increase in cargo and passengers, this may lead to catastrophic consequences in terms of human life loss. Therefore, fatal shipping accidents are the nightmares of seafarers and they are likely to be subjected to much public criticism.

It is incumbent upon policy-makers to implement efficient navigational safety strategies with the objective of reducing the likelihood of fatal shipping accidents and rescuing more persons if an accident does occur. Considering the limited available resources and budgets, policy-makers have to prioritize safety strategies. This can be achieved with the help of a comprehensive understanding of the contributory factors affecting the accident injury severity and mortalities.

To date, many studies have been conducted in this area while the majority of these studies were focused on the investigation of the contributory factors, and their effects on the fishing accident probabilities and consequences (e.g., Jin et al., 2001; Jin and Thunberg, 2005; Perez-Labajos et al., 2006, 2009; Roberts et al., 2010; Jin, 2014). There is also some literature regarding the strategies for reducing fishing accident probabilities and consequences (e.g., Stineman, 2009; Mata-Alvarez-Santullano and Souto-Iglesias, 2013). It should be pointed out that the results from the studies relating to fishing accidents were only applicable to fishing vessels. Considering all ship types, other researchers (e.g., Akten, 2004; Ozsoysal and Ozsoysal, 2006; Birpinar et al., 2009; Aydogdu et al., 2012) have investigated the relationship between the contributory factors and the risk of shipping accidents. Nevertheless, their results may still be biased because the data sources used for the analysis were subject to specific water areas. To avoid such shortcomings, this study will utilize worldwide shipping accident records to examine the effects of the contributory factors on the fatal shipping accident probability and mortalities.

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2. Literature review

Many researchers have focused their attentions on fishing vessel accidents. Jin et al. (2001) examined the determinants of the total losses and number of fatal and non-fatal crew injuries resulting from commercial fishing vessel accidents. It was found that the probability of a total loss of the vessel was the highest for a capsizing, followed by a sinking accident. In addition, fire/explosions and capsizings were expected to incur the greatest number of crew fatalities. Jin and Thunberg (2005) evaluated fishing vessel accident probability in the US Exclusive Economic Zone (EEZ), and found that higher wind speeds can increase the probability of fatal fishing ship accidents. Perez-Labajos et al. (2006, 2009) analyzed the inequality in the concentration of Spanish fishing accidents. Roberts et al. (2010) investigated the circumstances and causes of fishing ship accidents occurring in the UK from 1948 to 2008. The mortality was found to be highest during the winter months and during night-time periods. Jin (2014) examined the factors influencing the ship damage severity and crew injury severity. The severity of both ship damage and crew injury was positively related to the loss of vessel stability and sinking.

Eliopoulou and Papanikolaou (2007) analyzed the casualty data of large tankers as well as examined the effects of ship size/type and accident severity. Talley et al. (2006, 2008) investigated the determinants of the injury severity of passenger and cruise liner accidents. It was found that the injury severity was greater for ocean cruise accidents than for inland waterway and harbor/dinner cruise vessel accidents. Eliopoulou et al. (2013) presented an investigation of the recorded casualties of cellular type containerships for the period 1990–2012. It was found that the frequencies of fire and explosions exhibited very similar statistics.

It should be pointed out that the results from the above studies were only applicable to fishing vessels. However, in reality, the effects of the contributory factors to shipping accident risks may vary with ship types. Therefore, many other researchers have investigated the relationship between the contributory factors and the shipping accident risks for all ship types. For example, Akten (2004) analyzed shipping accidents occurring in the Bosphorus. The number of accidents occurring in darkness conditions was found to be nearly twice the number of occurring in daylight conditions. Using the maritime accident data from 2004, Ozsoysal and Ozsoysal (2006) examined the effects of ship type, accident time and dominant factors. It was found that collision/contact and grounding/stranding were the major accident types in the Istanbul Strait. Bogalecka and Popek (2008) analyzed 86 sea accidents from 2006 and found that the most accidents have less serious casualties. Birpinar et al. (2009) evaluated the environmental effects of maritime traffic on shipping accident risks in the Bosphorus. Uluscu et al. (2009) incorporated a probabilistic accident risk model into the simulation model to analyze the safety risks of transit vessel maritime traffic in the Bosphorus. Chin and Debnath (2009) and Debnath and Chin (2010) explored the influencing factors of shipping collision risks in the Singapore Port waters. Aydogdu et al. (2012) used Marine Traffic Fast Time Simulation (MTFTS) tools to evaluate the effect of local traffic management in reducing shipping accident risks. The Local Traffic Separation Schemes (LTSS) were proposed to improve navigation safety in the Strait of Istanbul. Weng et al. (2012) examined the effects of time and traffic directions on shipping accident frequency in the Singapore Strait.

Nevertheless, the results from these studies may still be biased even though all ship types were considered. This is because the data sources used for the analysis were subject to specific water areas (e.g., the Istanbul Strait). In addition, the majority of the existing studies were concerned with shipping accident probability and the corresponding risk mitigation strategies. However, the public have shown great concern about the mortalities resulting from shipping accidents. Unfortunately, there has not been a great deal of literature on mortalities resulting from shipping accidents.

3. Objectives and contributions

The objective of this study is first to develop a shipping accident injury severity model to predict the fatal accident probability using worldwide shipping accident data. A mortality count estimation model is then developed to predict the number of mortalities resulting from shipping accidents. The effects of the contributory factors on shipping accident mortalities are also examined in this study. The contribution of this study is twofold. First, this study makes an initiative for the assessment of shipping accident mortality. Second, the results of this study are beneficial for policy-makers in proposing efficient strategies/measures to reduce fatal accident probability and mortalities.

4. Data

Worldwide shipping accidents occurred between January, 2001 and February, 2011 were obtained from the shipping accident database managed by Lloyd's List Intelligence Company. This

Table 1
Variable descriptions.

Variables	Notation	Descriptions	Proportions
Accident injury severity	y	1 for fatal accident, 0 otherwise	3.77% for fatal accidents
Ship type	x_{st}	1 for cruise ship, 0 otherwise	3.87% for cruise ships
Collision	x_{col}	1 if a collision is occurred, 0 otherwise	19.17% involved in collision accidents
Fire/explosion	x_{fire}	1 if a fire/explosion is occurred, 0 otherwise	8.37% involved in fire/explosion accidents
Machinery/hull damage/failure	x_{hull}	1 if machinery failure or hull damage occurs, 0 otherwise	37.67% involved in machinery failure or a hull damage
Contact	x_{cont}	1 if a contact occurrs, 0 otherwise	8.48% involved in contact accidents
Grounding	x_{grou}	1 if a grounding occurs, 0 otherwise	18.72% involved in grounding accidents
Sinking	x_{sin}	1 if a sinking occurs, 0 otherwise	7.70% involved in sinking accidents
Miscellaneous	x_{mis}	1 if the accident is caused by miscellaneous non-classified causes, 0 otherwise	12.79% involved in miscellaneous accidents
Weather conditions	x_{we}	1 if the accident is occurred under adverse weather conditions, 0 otherwise	4.33% of accidents occurred under adverse weather conditions
Accident location	x_{loc}	1 if the accident is occurred far away from the coastal area/harbor/ports, 0 otherwise	6.17% of accidents occurred far away from the coastal area/harbor/ports
Accident time	x_{day}	0 if the accident occurs during the daytime period (daylight conditions), 1 for the night-time period (darkness conditions)	50.43% of accidents occurred during the daylight conditions
Number of people	x_{pas}	The number of people on board the ship	-

Note: Mean of the mortalities in both accident injury severity levels = 19.71; Variance of the mortalities in both accident injury severity levels = 11912.