



An analysis of safety and security risks in container shipping operations: A case study of Taiwan



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ABSTRACT

Safety and security has been an increasing concern in container shipping over the past few decades. In this paper, three major risk categories, namely, risks associated with information flow, risks associated with physical flow, and risks associated with payment flow are categorised and analysed. The paper uses Taiwan as a case study aiming to provide some insight into the management of safety and security in a wider maritime context.

Both qualitative and quantitative research methods are employed in this paper. An interview survey is undertaken to explore and identify the risk factors in container shipping, and a questionnaire survey is then conducted to collect the relevant data. In order to conduct a comprehensive risk analysis, risk scale is calculated to rank the risk factors using the mean value method and the stochastic dominance method; and risk map is used as the main analytical method to identify the level of risks. It is found that with regard to maritime safety and security damage, risks associated with physical flow as a whole is more likely to have serious impacts than risks associated with information flow and risks associated with payment flow. However, 'shippers hiding cargo information' as a factor in risks associated with information flow is the most serious one among all the risk factors in terms of risk scale.

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1. Introduction

Maritime safety and security has always been a concern to the shipping industry. Although a number of international legal instruments such as the SOLAS Convention (the International Convention for the Safety of Life at Sea), the ISM Code (the International Safety Management Code), and the ISPS Code (the International Ship and Port Facility Security Code), have been adopted by the International Maritime Organization (IMO) to tackle the issue (IMO, 2010, 2012), the risks relating to maritime safety and security are still high as evidenced by the periodical occurrence of maritime safety and security incidents and the huge losses caused in most cases.

As a main component in the shipping business, container shipping is playing an increasingly significant role in international trade by carrying approximately 90% of the manufactured cargos in volume (Hellenic Shipping News, 2013). For such an important maritime business, ensuring its safety and security and minimising the risks and the potential losses caused by the incidents in shipping operations is undoubtedly an issue of great importance.

There have been a number of studies addressing the maritime safety and security issue from different perspectives, e.g. the human aspect factors (Lu and Shang, 2005; Hetherington et al., 2006; Lu and Tsai, 2008; 2010), the technological factors pertaining to ships (e.g., Lun et al., 2008; Kim et al., 2013), and the shipping operational factors (e.g., Talley, 1996; Notteboom, 2006; Husdal and Bråthen, 2010; Yang, 2010; Wang et al., 2014). This paper will focus on risks in shipping operations but attempt to extend the research in this area by approaching the issue in a more systematic and inclusive way.

Risk is defined as "the chance, in quantitative terms, of a defined hazard occurring" (The Royal Society, 1992, p. 4). It combines "a probabilistic measure of the occurrence of the primary event(s) with a measure of the consequences of that/those event(s)" (The Royal Society, 1992, p. 4). In the shipping operation aspect, a number of risk factors have been identified. For example, Talley (1996) found that unlicensed ship operators and smaller ship size contributed to the increase of risk and severity of cargo damage in container shipping. Drewry (2009) identified a list of risk factors associated with container logistics operations such as documentation, booking and invoicing errors, errors in customs regulatory compliance and in security compliance, strikes and transport congestions, theft and cargo loss or damage, piracy, and terrorist attacks. Fu et al. (2010) reported that piracy has been a significant threat to container liners. Yang (2010, 2011) found that the

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container security initiative such as “supply chain partners not transmitting essential information on time” and “processing documents being detained by government departments (e.g. customs)” had significant impact on Taiwan’s shipping industry. [Notteboom \(2006\)](#) investigated the sources of ship schedule unreliability in the East Asia-Europe routes and reported that the main sources that had led to ship unreliability are waiting time and delays caused by port strikes, unstable weather and sea conditions, port/terminal/transport congestion, and port/terminal productivity being below expectations.

Although some good insight has been provided by these studies, an inclusive overview of all the potential risks in shipping operations and their relative importance in terms of impact on maritime safety and security has not been established. Given that shipping companies normally have limited resource to invest in managing risks, it would be useful for them to know where to invest and how to invest better. It would therefore be helpful if indications could be established on which risk factors are more likely to cause incidents and which are more likely to cause very serious losses. To be able to assist in this, this paper aims to provide an inclusive empirical analysis of the risks in container shipping operations that may cause maritime safety and security related damage. In order to be inclusive, this paper considers the three logistic flows in shipping operations, i.e., the information flow, the physical flow and the finance flow. Generally defined, information flow contains information collection and transferring between companies; physical flow contains cargo delivery from manufacture section through transportation section to final consumers; and payment flow refers to the monetary payment from the customer sector to the business sector that provides the goods or services ([Spekman and Davis, 2004](#)).

Based on an extensive review of literature including those on non-maritime sectors, we found that the following issues could be regarded as risk factors in container shipping operations -

Risks associated with information flow:

- Using different communication channels, e.g. telephone, Email, EDI, in the supply chain and consequently increasing the time of information transmission ([Metters, 1997](#)).
- supply chain partners not transmitting essential information on time ([Angulo et al., 2004](#); [Yang, 2010, 2011](#)).
- processing documents being detained by government departments (e.g. customs) ([Husdal and Bråthen, 2010](#); [Yang, 2010](#)).
- shipping company not transmitting essential information on time ([Angulo et al., 2004](#)).
- lack of information security during the information flow ([Sharma and Gupta, 2002](#); [Finch, 2004](#); [Qi and Zhang, 2008](#)).
- information asymmetry/ incompleteness ([Forrester, 1961](#); [Lee et al., 1997](#); [Angulo et al., 2004](#); [Husdal and Bråthen, 2010](#)).
- lack of information standardisation and compatibility ([Tummala and Schoenherr, 2011](#)).
- IT infrastructure breakdown or crash ([Qi and Zhang, 2008](#); [Swabey, 2009](#); [Tummala and Schoenherr, 2011](#)).
- unsuitable human operation on IT infrastructure ([Millman, 2007](#)).
- unsuitable human operation on application software ([Millman, 2007](#)).

Risks associated with physical flow:

- Port strike ([Notteboom, 2006](#); [Drewry, 2009](#); [Husdal and Bråthen, 2010](#); [Tummala and Schoenherr, 2011](#)).
- port congestion (unexpected waiting times before berthing or before starting loading/discharging) ([Notteboom, 2006](#); [Drewry, 2009](#); [Tummala and Schoenherr, 2011](#)).

- port/terminal productivity being below expectations (loading/discharging) ([Notteboom, 2006](#); [Tummala and Schoenherr, 2011](#)).
- unstable weather ([Notteboom, 2006](#); [Husdal and Bråthen, 2010](#)).
- inappropriate empty container transportation ([Song et al., 2005](#); [Drewry, 2006](#); [Song and Dong, 2011](#)).
- lack of flexibility of fleet size and designed schedules ([Song et al., 2005](#); [Qi and Song, 2012](#)).
- oil price rise ([Notteboom and Vernimmen, 2009](#); [Husdal and Bråthen, 2010](#)).
- damage to containers or cargo due to terminal operators’ improper loading/unloading operations ([Husdal and Bråthen, 2010](#)).
- cargo being stolen from unsealed containers ([Drewry, 2009](#); [Husdal and Bråthen, 2010](#)).
- damage caused by transporting dangerous goods ([Talley, 1996](#); [Husdal and Bråthen, 2010](#)).
- damage to ship or quay due to improper berth operations ([Talley, 1996](#); [Husdal and Bråthen, 2010](#)).
- attack from pirates or terrorists ([Drewry, 2009](#); [Fu et al., 2010](#); [Tummala and Schoenherr, 2011](#); [Liwång et al., 2013](#)).

Risks associated with payment flow:

- Change of currency exchange rate during payment process ([Tummala and Schoenherr, 2011](#)).
- payment delay from partners or shippers ([Seyoum, 2009](#)).
- unrealised contract with partners ([Tummala and Schoenherr, 2011](#)).
- shippers going into bankruptcy ([Husdal and Bråthen, 2010](#); [Tummala and Schoenherr, 2011](#)).
- shippers breaking the contract or reducing the container volume ([Chen, 2008](#)).
- having partners with bad credit ([Tummala and Schoenherr, 2011](#)).

Flowing from the above, several questions may arise: Does the above list cover all the risks in container shipping operations? Do they all impact on maritime safety and security and, if so, to what extent? How the importance of each factor could be ranked and what response strategies would be appropriate for dealing with different risks? This paper attempts to answer these questions by meeting the following research objectives:

- (1) To inclusively identify risk factors in container shipping operations.
- (2) To measure the level of risk likelihood and risk consequence of each risk factor in respect of maritime safety and security related losses.
- (3) To analyse the relative importance of each risk factor with regard to maritime safety and security incident consequences.
- (4) To differentiate response strategies to different risk factors.

The rest of this paper is organised as follows: Section 2 describes the research methods used in this study. Section 3 applies the research methods to our context, presents the survey results, and performs the data analysis. Conclusions are drawn in Section 4.

Before entering into detailed discussion, it is necessary to point out that in many other studies about maritime safety and maritime security, the two elements are often treated separately mainly because they are different from each other in their nature and causes. Maritime safety incidents are normally caused by technical failures or human factors whereas maritime security incidents are

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