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The Effectiveness of New Inspection Regime on Port State Control Inspection

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Abstract

Port state control (PSC) inspection is an important measure to improve ship safety and reduce ship accident rate. To improve the effectiveness of PSC inspections, some MoUs have begun to implement new inspection regime (NIR). However, the effectiveness of NIR remains to be studied. Then this study aims to verify the effectiveness of NIR and improve shipping safety. In this study, Bayesian Network model is used to establish the relationship between NIR, ship deficiencies, detention and ship accident to explore the impact of NIR on maritime safety. The data in this study are from PSC inspection data in the Tokyo Memorandum of Understanding (MoU) and accident data in the International Maritime Organization (IMO). By analyzing the changes of the number of ship deficiency, detention rate and accident rate before and after NIR implementation, the effectiveness of NIR can be verified. The results show that the implementation of NIR does not effectively reduce the number of substandard ships, but the number of ships with serious deficiencies is significantly reduced. However, ship accident rate has not declined. Therefore, it is believed that Tokyo MoU needs to further improve the effectiveness of NIR and strengthen supervision of defective ships.

Keywords

Port State Control, New Inspection Regime, Effectiveness, Maritime Safety

1. Introduction

As is known to all, shipping plays an important and irreplaceable role in the international cargo transportation and trade exchange. However, maritime transport is easily affected by environmental changes, human factors and ship inherent attributes, which causes maritime traffic accidents. Once ship accidents occur, they usually cause huge economic losses, environmental damage and even

casualties. It is generally believed that port state control (PSC) inspection can reduce substandard or high-risk vessels and play a very important role in improving maritime safety. Ports will inspect ships entering ports in order to ensure that they meet relevant international conventions and do not threaten maritime safety and environment.

There have been many measures in order to improve ship safety, such as flag state control (FSC), but they have failed to effectively reduce ship risk while PSC has been doing a good job. Because of the importance of PSC inspection to shipping safety, studies on PSC inspection are increasing. Existing studies indicate that the accident rate of inspected ships will be significantly reduced (Knapp & Franses, 2007). Cariou et al. (2008) realized the importance of PSC inspection to discover ship serious deficiencies, and concluded that it can significantly reduce ship accidents. However, due to high cost and complexity of inspection, it is sometimes difficult to ensure the effectiveness of port selection and inspection for target ships. When selecting the target ship for inspection, ports will qualitatively evaluate ship risk based on the ships' inherent attributes such as age, flag and type of ship as well as ships' previous inspection records. Although PSC inspection can reduce the risk of ship accidents, rapid and continuous inspections of same ship will not double accident risk reduction, which also increases economic pressure on inspection authorities and ship owners. Ship experts generally agree that the effect of inspection on ships usually lasts only about one year (Heij et al., 2011). Therefore, both too long and too short inspection interval time have poor effect on ship safety. How to reasonably evaluate ship risk and select appropriate ships for inspection has also become the focus of attention. In order to improve the effectiveness of PSC inspection, new inspection regime (NIR) has appeared. Paris MoU implemented NIR in 2011, and Tokyo MoU followed Paris MoU's experience and implemented NIR on January 1, 2014.

Although NIR has a more perfect system compared with the traditional PSC inspection, there are still some limitations. Therefore, this study will analyze the effectiveness of NIR. In this study, NIR is taken as a separate variable. Based on whether NIR was implemented or not, the effectiveness of NIR is discussed from three aspects: defect rate, retention rate and accident rate. By evaluating the effectiveness, NIR can also be further improved.

The rest of this study is arranged as follows: Section 2 shows the related literature review. In Section 3, data description and model construction are shown. The results of the model are discussed and analyzed in Section 4. Finally, the conclusions are presented in Section 5.

2. Literature Review

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deliberate, using specifications that anticipate your paper as one part of the entire journals, and not as an independent document. Please do not revise any of the current designations. The Tokyo MoU's NIR specifies conditions for the assessment of ship risks. It analyzes ship risk based on ship type, age, flag, recognized organization, company performance, deficiencies and detentions and assigns corresponding weights to each factor, then finally evaluates the ship risk according to sum of weighting points. Many studies show that a number of factors can significantly impact on ship risk, such as ship age, ship type, ship size and so on (Hänninen & Kujala, 2014; Hänninen et al., 2014). For flag, it is also important factor that affects PSC inspection (Kara, 2016). The number of ship deficiencies can more intuitively show ship risk. According to the NIR of Tokyo MoU, ships with more than five deficiencies recorded in each inspection over the past 36 months, are considered to be at higher risk. When ships do not meet requirements of relevant international conventions and their deficiencies have a significant impact on ship safety, ships will be detained. Fu et al. (2020) found that ship type, ship age, deadweight and gross tonnage are closely related to the identification of ship defects. For example, Cariou and Wolff (2015) found that bulk ships, reefer and older ships have higher detention rate and quantity of defects by analyzing ship type and ship age. Cariou et al. (2007) also showed that ship age, ship type, flag is an important factor to predict the number of ship defect and multiple inspections can effectively reduce ship defects.

PSC inspection can not only reduce ship accident rate, but also predict the risk of accidents to a certain extent. Heij and Knapp (2018) concluded that ships are more likely to accidents when the results of PSC inspection indicates they are at high risk. In addition, Heij and Knapp (2018) also proposed a risk-driven strategy to select target ship from the aspect of safety gains. According to NIR, ship risk can be defined to help port states determine ship inspection priority and interval time. High-risk ships may be inspected within two to four months after the last inspection, while standard-risk and low-risk ships may be inspected after longer interval time (Xiao et al., 2020). In this way, the ship can be more targeted for inspection.

Although most studies of PSC inspection show the effectiveness of PSC inspection (Fan et al., 2019), there are few studies on the effectiveness of NIR, especially on Tokyo MoU. Compared with traditional PSC inspection, whether NIR can reduce accident risk and improve overall level of shipping safety more effectively is still worth discussing. In addition, Bayesian Network (BN) is the most commonly used modeling tool in the research of maritime safety. Hänninen (2014) evaluated BN from different perspectives, and he believed that BN had some shortcomings, but also had many irreplaceable advantages. Based on convenience of Bayesian networks when analyzing uncertain causal relationship, many studies on shipping safety adopt this method (Yang et al., 2018; Bang & Jang, 2012). Therefore, this study uses BN to analyze the effectiveness of NIR based on Tokyo MoU.

3. Data Description and Model Construction

The data used in this study are mainly from two sources: the PSC inspection database from Tokyo MoU (Tokyo MoU, 2018) which contains inherent attributes, defects and detention of ships inspected and the Marine Casualties and Incidents from International Maritime Organization (IMO) (IMO, 2018) which shows the ships involved in each incident. The purpose of this study is to analyze the effectiveness of NIR, so inspection data and accident data of the three years before and after the implementation of NIR are only selected. The PSC inspection database comprises 237,133 inspection cases in the Tokyo MoU from January 2011 to December 2016. In addition, the information of accidents covers more than 2000 incident cases in the Marine Casualties and Incidents from January 2000 to December 2018, containing information related to marine casualties and incidents.

As a powerful modeling tool, BN is often used to study maritime safety (Hänninen, 2014). BN can directly input data to establish the dependency relationship between variables, and finally form a directed acyclic graph composed of nodes and arrows, which can visually represent the relationship between variables. Each node represents a variable, the node at which the arrow begins is called the "parent node", the node at which it points is called the "child node", and the arrow represents the causal relationship between the two variables connected. Bayesian Search (BS), which is one of the most popular algorithms, is used when analyzing and learning model structure.

According to the description in Tokyo MoU's NIR, NIR has taken into account the impact of ship's inherent attributes such as flag and ship age on ship risk. Therefore, in order to verify the effectiveness of NIR, whether NIR is implemented or not is taken as a separate variable in this study. In addition, both traditional PSC inspection and NIR are directly related to ship deficiencies and detention. The change of accident rate is the most intuitive condition to evaluate the effectiveness of inspection. All nodes in the model include two states: yes and no. For variable NIR, state "yes" represents new inspection regime is still not implemented and state "no" indicates it is after implementation of NIR. **Figure 1** shows the model in this study. The probability distribution of each state of all nodes is shown in **Figure 2**.

4. Results Discussion

From the inspection data, there are 114,095 inspection cases during 3 years before the implementation of NIR and there are 123,038 inspection cases during 3 years after the implementation of NIR. The amount of inspection after the implementation of NIR increases slightly. Too much inspection will both increase the burden of ports and make shipowners face higher cost, so it should be concerned about the effectiveness of each inspection instead of the number of inspections. Therefore, the impact of NIR on ship deficiencies and detention still needs to be analyzed. **Table 1** describes the impact of NIR on ship deficiencies

and detention before and after implementation, as well as the change of accident rate.

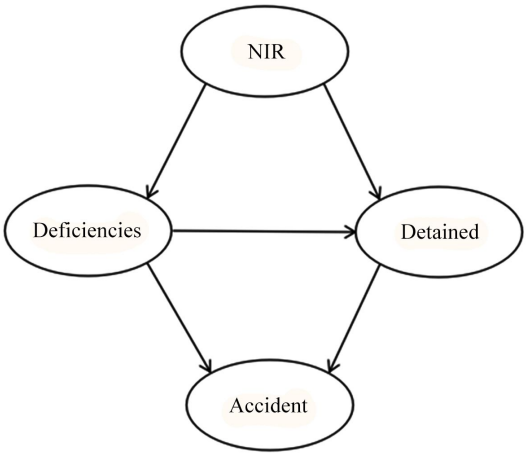

Figure 1. The model in this study.

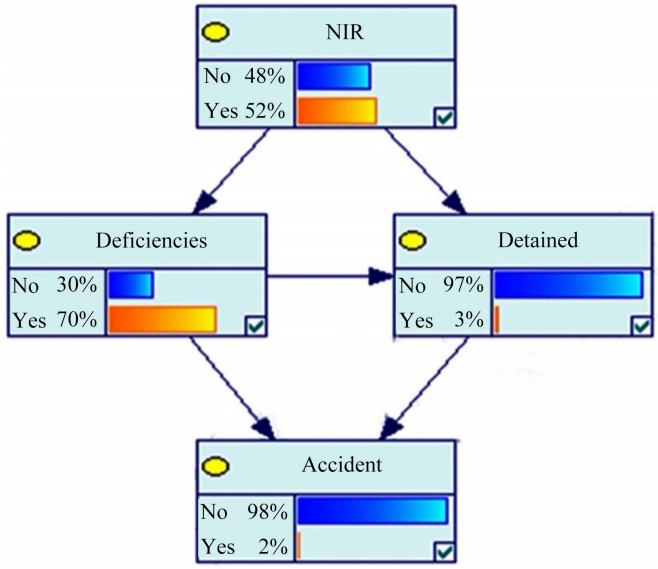

Figure 2. The probability distribution of all nodes.

Table 1. The effects of NIR on other variables.

Variables and states		NIR	
		No	Yes
Deficiencies	No	30%	30%
	Yes	70%	70%
Detained	No	96%	97%
	Yes	4%	3%
Accident	No	98%	98%
	Yes	2%	2%

As Table 1 shown, the proportion of ships with deficiencies before and after implementation of NIR do not change significantly, which is 70%. This shows that the implementation of NIR has not effectively reduced the number of substandard ships. For detained ships, ship detention rate before implementation of NIR is 4%, but after implementation of NIR, it is 3%. The detention rate has decreased, which indicates that fewer ships have serious defects that will affect maritime safety and lead to ship accident. From the point of view of ship accidents, ship accident rate has not changed. This manifests that NIR has not effectively improved maritime safety.

5. Conclusion

This study uses BN to analyze the changes of ship deficiencies, detention rate and accident rate before and after the implementation of NIR for Tokyo MoU. Then it explores the effectiveness of the NIR implemented by Tokyo MoU and puts forward relevant suggestions based on research results. It has been discovered that the proportion of defective ships does not change obviously before and after implementation of NIR, but ship detention rate decreased. This indicates that although NIR cannot effectively reduce the number of substandard ships, the number of ships with serious defects is reduced so the possibility of ships being detained is reduced. For ship accident, NIR cannot effectively reduce the ship accident rate, which demonstrates that NIR has done a less job in reducing ship risks and it has not effectively improved maritime safety. Therefore, the effectiveness of NIR for Tokyo MoU needs to be further improved. This study suggests that Tokyo MoU should further strengthen PSC inspection of ships. Besides, more strict supervision and control should be carried out over defective ships to reduce the number of ships with defects.

This study also has some limitations. This study only considers whether the ship has deficiencies. If the number of ship defects can be added to the analysis, research results will be more perfect. The changes in ship risk levels are added into future studies, which would give a better indication of the effectiveness of NIR.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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