ISSN: 2688-9323

Maritime Security: Improving Port State Control Efficiency with Ship Selection Optimization

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Abstract

Maritime Accidents have been a major issue for the international maritime community since the beginning of shipping. Maintaining maritime security is particularly significant as maritime accidents usually result in the death or injury of people on board, damage to property and threats to the environment. Therefore, Port State Control inspection as one of the most important methods for protecting maritime security is widely concerned. This study reviews the research on the efficiency of Port State Control inspection and finds that it is possible to optimize Port State Control inspection process based on the New Inspection Regime and combined with ship inherent properties and previous inspection records. On the one hand, for the Port State Control authorities, the improved inspection process can increase the probability of substandard ships being inspected and thus reduce the accident rate and save time, human resource and expenses. On the other hand, for shipowners, it can reduce the Berthing time and maintain the good condition of ships.

Keywords

Port State Control; Efficiency; Maritime Security; Inspection Process.

1. Introduction

Maritime Accidents have been a major issue for the international maritime community since the beginning of shipping. Luo and Shin [1] indicate that in the past 36 years from 1978 to 2013, the total number of maritime accidents was 63,991, an average of 1,777 per year. The undesirable effects of maritime accidents such as the damage to maritime property, people on board and the environment that are some of the concerns to authorities and researches [2].

Hence, many international organizations and national Maritime Safety Administrations (MSAs) have issued numerous rules and regulations on safety standards, as well as various guidelines on the safe operation of ships [3]. Ten Memorandum of Understanding (MOUs) on Port State Control (PSC) have been signed to improve maritime security. As an internationally recognized system for inspecting foreign ships, PSC is required to identify substandard ships entering their ports in accordance with international conventions and protocols [4]. Since 2011, a New Inspection Regime (NIR) has been implemented by the PSC of MoU member countries, according to it, the scope, frequency and priority of inspections are determined by the ship's risk profile (SRP) - ships can be classified as high risk ships (HRS), standard risk ships (SRS) and low risk ships (LRS).The interval between regular inspections for HRS is 2-4 months ,for SRS is 5-8 months and for HRS is 9-18 months [5]. Xiao *et al.* [6] contrast the average efficiency scores of the three inspection regimes to verify that NIR is more economically efficient than other inspection regimes. This means that in the future when looking at ways to further improve the efficiency of PSC inspection, we can base on the NIR.

The purpose of this study is to explore the way to further optimize the PSC inspection process by combing the related literature so that substandard ships can be screened out accurately and quickly, thus reducing the probability of maritime accidents.

ISSN: 2688-9323

2. Literature References

PSC inspection has been confirmed that it has an important impact on improving the quality of ships and protecting maritime safety [7]. Fan *et al.* [8] verify the effectiveness of PSC inspection in preventing accidents. The general process of PSC inspection is as follows: the Port State Control Officer (PSCO) selects the ship to be inspected and conducts an initial inspection (boarding and visual inspection, certificate and document inspection); if the ship is found to have significant deficiencies, a detailed inspection is conducted and an inspection report is generated, in which the non-conformities are referred to as "deficiencies" including the number and type of deficiencies [9]. In order to achieve uniform and effective PSC inspections, regional MOUs on PSC were established. One of the key issues facing the MOUs on PSC is how to select ships for inspection, as there is no capacity and no necessary to inspect all visiting foreign ships due to resource constraints [10]. Since not all ships are substandard, the emphasis to improving the efficiency of PSC inspection is how to accurately and quickly screen out substandard ships. It is principal to explore the factors that affect the PSC inspection, so as to provide selecting reference for PSCOs based on this information.

Fu *et al.* [11] apply the improved Apriori model to analyze the correlation between ship deficiencies and also introduce ship intrinsic properties to explore how to improve ship inspection efficiency and ship safety conditions. Fan *et al.* [12] demonstrate that ship inherent property and PSC inspection deficiencies have a significant impact on ship accidents. Wang *et al.* [13] claim that the safety condition related defects of the ship and the technical features of inspected ship mainly affect the PSC inspection. Wang *et al.* [14] find that a ship with greater number of detained times before has a worse performance in the latter PSC inspections. Yang *et al.* [15] analyze the impact of the implementation of NIR on the PSC inspection system and ship quality from macro and micro perspectives. They conclude that the impact of NIR is generally positive, as it motivates ship owners to maintain their ships at high quality level. However, Shen *et al.* [16] indicate that the criteria for judging a ship as a standard risk ship (SRS) in the NIR of PSC are too broad. Therefore, they develop a selection system that uses PSC inspection records to identify potential risks of target ships classified as SRS and confirm that the system hit 83.3% of hidden risk ships in the SRS category at the next PSC inspection. This means that the classification of ship risk level in NIR is not precise enough to be fully relied on to select ships for inspection. Furthermore, Xiao *et al.* [4] discover that ships' characteristics and number of deficiencies are related to whether the ship will be detained. Moreover, ship age, ship type, performance of flag States and the number of deficiencies considered important by the NIR are the critical factors.

Through the above literature researching and analysis, we can explore the influence on the probability of maritime accidents of ships based on the risk level and inspection interval of NIR, combined with ship inherent property, the deficiencies recorded in inspection report and the number of detentions. The factors which play significant roles in maritime accidents can be filtered out and provided to PSCOs to more precisely select the inspected ships which can be the unqualified ships that may have accidents. Hence, the purpose of optimizing the selection of the ship selection mechanism and then improving the efficiency of inspection is achieved. Then, as many unqualified ships as possible can be inspected within the limited resource constraints, thus reducing the probability of marine accidents and achieving the ultimate goal of protecting maritime security.

3. Method

Bayesian Network (BN) is currently one of the most effective theoretical models in the field of uncertain knowledge representation and reasoning. It is a Directed Acyclic Graph (DAG) proposed by Pearl in 1988, which consists of nodes representing variables and directed edges

ISSN: 2688-9323

connecting these nodes. The nodes represent random variables, the directed edges between the nodes represent the interrelationships between the nodes (from the parent node to its children), and the conditional probabilities are used to express the strength of the relationships, and the information is expressed in terms of prior probabilities if there is no parent node. BN is suitable for expressing and analyzing uncertain and probabilistic events, and can make inferences from incomplete, imprecise or uncertain knowledge or information. Moreover, BN as a quantitative modeling tool is used in the field of maritime traffic safety more and more commonly [17]. Lim et al. [2] showed that 14% of the maritime risk analysis used BN. Hänninen et al. [18] use BN to construct an analytical model of maritime safety management. Fan et al. [8] to explore the influence of PSC inspection deficiencies on accident consequence with BN. Yang et al. [19] combine data-driven BN with the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) to provide useful insights on the dynamic evaluation of rational control strategies. Fan et al. [12] identify the structural connections among the PSC inspection deficiencies based on the BN model. Therefore, this study will employ the BN to establish the research model to explore associations among various possible factors, PSC inspection outcome and accident rate. Thus, we can acquire the key factors which significantly affect accident rate for PSCOs to select the checked ship precisely. The preliminary conceptual model for this study is as Figure 1.

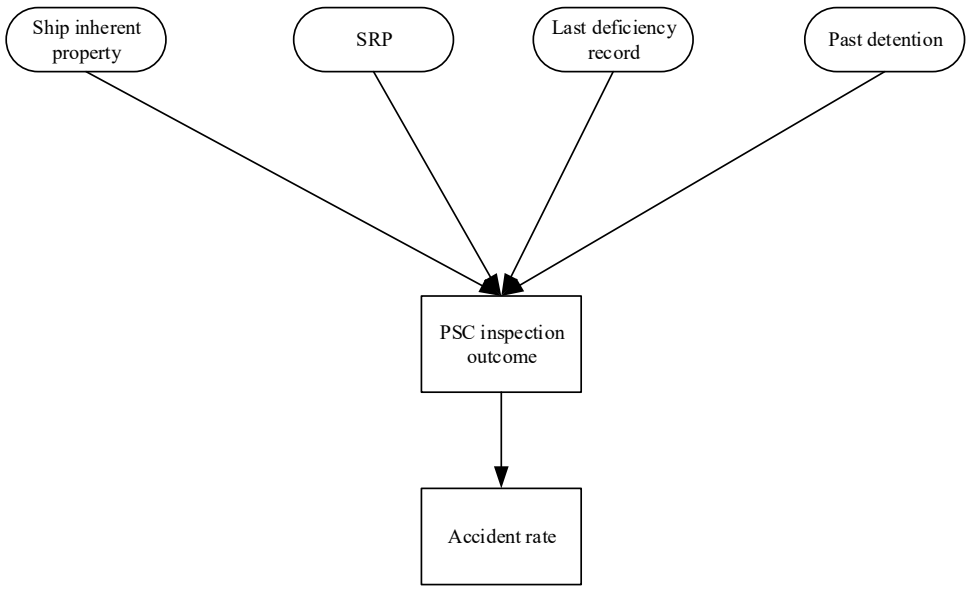

Figure 1. Conceptual Model

4. Conclusion

This study focuses on the static influencing factors to optimize the mechanism of ship selection so as to improve the efficiency of PSC inspection and thus to reduce the occurrence of maritime accidents and protect maritime security. Future research could consider exploring some dynamic influencing factors, such as time. At the same time, some of the influencing factors can be more delicately divided to find out the most critical influencing items, for instance, the location and personnel conducting the PSC inspection and the length of the detention. In addition to seek the potential factors, the research methods can also be more diverse, such as apply simulation and regression model into analysis.

Acknowledgments

Natural Science Foundation.

ISSN: 2688-9323

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