Learning Officer Performance Variability from Dangerous Ship Encounter Situations in Ship Simulator

Adhita, I Gde Manik Sukanegara
Fuchi, Masaki
Konishi, Tsukasa
Fujimoto, Shoji

(Citation)
日本航海学会誌 NAVIGATION,223:15-16

(Issue Date)
2023-02-09

(Resource Type)
journal article

(Version)
Version of Record

Learning Officer Performance Variability from Dangerous Ship Encounter Situations in Ship Simulator

I Gde Manik Sukanegara ADHITA*, Masaki FUCHI**, Tsukasa KONISHI**, Shoji FUJIMOTO**

Key Words: maritime accident, Functional Resonance Analysis Method (FRAM), human reliability, ship safety, ship collision

1. Introduction

Increasing demand for safety in today's complex socio-technical system is inevitable. In the past two decades, a discourse in safety analysis has been raising some popular new terms, namely resilience engineering [1] and Safety-II [2]. The implementation of advanced technology in the industry causes the work for systems to become more complicated. It implies the situation where the unexpected situation becomes more intractable. As a result, it is argued that the traditional safety approach, which used the accident as the main source to enhance system safety, has become weak to be implemented. In this case, a new perspective is needed as a complementary and enhanced safety analysis. Performance variability is the key concept for managing safety in complex socio-technical systems [3].

Today's ship has equipped with advanced information technology. The need to apply automation technology for navigation is also increasing. The issue of reducing the number of crew on board is in-line with the establishment of the four degrees of Maritime Autonomous Surface Ship stated by IMO [4]. It requires future seafarers to have extraordinary navigation skills to compete with technological development. Therefore, in this study, we tried to address officer performance, in which human adaptability and flexibility are essential for future ship navigation. By applying the concept of Safety-II, this study aimed to provide a clearer understanding of officer performance to maintain the system works "normally" under unexpected situations. As a result, we could present what variability performance should be managed and improved to create a higher resilient level in ship navigation.

2. Data Collection

The context of unexpected ship encounter situations is generated by creating a simulation scenario in a ship simulator. This kind of event is hard to capture in actual field observation. This causes simulation experiments to be considered more relevant for data collection. Seven licensed officers, four Japanese and three Korean, are invited to participate in this simulation. All simulations are done with the approval of the participant, and the data is presented anonymously. Participants onboard experiences are varied from a year as a cadet, between three to ten years, and more than ten years. Data is captured in the form of video and audio recordings. Furthermore, a structured interview is performed to understand better every officer's decision to operate their ship.

3. Methodology

3.1. Safety-II

Safety II offers an alternative perspective by viewing safety as an emergent phenomenon arising from a complex socio-technical system rather than a property of the system [5]. System performance, in this perspective, is acknowledged to be variable. Indeed, the variability comes because of the involvement of human action. It explains why performance adjustment is essential in everyday operation (Work-As-Done).

In this study, Safety-II concept has been applied to learn how this variability performance affects system output, in specific, the potency to overcome difficult encounter situations. On the basis of the system functional level, this study specifies the variability performance of ship officers in the form of the system's function [6]. Further elaboration on function dependency is presented in a specific instant generated from a simulation experiment.

3.2. Experimental Design

This experiment is intentionally designed to present unexpected ship encounter situations. The participant was asked to do a simulation, in total, for about 15 minutes. The scenario takes place in a congested and narrow area with many fishing vessels and islands. In addition, two main targets, called Target A and Target B, were prepared with unusual behavior to create unexpected encounter situations.

4. Result and Analysis

A relatively similar system propagation has been found in two separate patterns. The first pattern is made by participants B, C, and D. The second similar system propagation happens in the simulation done by participants A, D, E, and G. The critical point of this difference is happening in the first 3 minutes of the simulation. While Participants B, C, and D decided to change their ship course from 180º to 178º, the other participants, A, D, E, and G, decided to go straight and maintain their original heading. It implies the different position of the participant's ship with the first and second targets, Target A and B. As a result, they are

*学生会員 神戸大学 大学院 海事科学研究科
sukanegaramanik@gmail.com
**正会員 神戸大学 大学院 海事科学研究科

producing a different adjustment to perform appropriate navigation against the target ship.

The simulation has presented a critical point for successful ship navigation: how the officer could make an early decision after recognizing the strange behavior of the target ship. In addition, Participant G, in the second encounter with Target B, has shown how performance variability can be sensitive regarding the timing of function activation and ship's angle, negatively affecting system output.

5. Discussion

The spirit presented in this work is how to understand safety from its present. The learning process starts with how solutions are created, in which the motivation and initiative of the officer are valued as a resource. Furthermore, technological developments can always take advantage of human flexibility without having to remove it from the system.

The simulation has revealed that at some point, the participant with less onboard experience could perform as participants with higher onboard experience did. The noticeable difference in performance adjustment between young and senior seafarers is how they utilize communication aids, such as the ship's whistle and VHF radio. This can be used to indicate that officer performance's flexibility should be enhanced. This study, indeed, presents the specific result of a specific scenario that cannot be generalized for every situation. However, the commitment to appreciate human performance [7] is what we try to obey. Human performance is variable, and that is what makes the system flexible and resilient.

6. Conclusions

The analysis indicates that timing in the function's activation and rudder angle strongly affect the output of the maneuvering process. Practical knowledge of officer adaptability in unexpected encounter situations has also been obtained based on how the adjustment takes place in the simulation. This study presents one of the ways to understand safety from routine challenges happening in everyday ship operations. It provides a small example of what to learn from a successful activity.

7. Acknowledgment

We would like to acknowledge the Japan Society for the Promotion of Science (JSPS KAKENHI Grant Number 22K04598) for funding this research. We would also like to thank all participants for participating in this research. Their willingness to share their knowledge has been essential for this research.

References

[1] Hollnagel E, Woods D D and Leveson N 2006 *Resilience Engineering: Concepts and Precepts* (Ashgate)

[2] Hollnagel E 2014 *Safety-I and Safety-II: The Past and Future of Safety Management* (CRC Press)

[3] Woods D D 2015 Four concepts for resilience and the implications for the future of resilience engineering *Reliab. Eng. Syst. Saf.* **141** 5–9

[4] IMO 2021 Outcome of the Regulatory Scoping Exercise for the Use of Maritime Autonomous Surface Ships (Mass) *MSC.1/Circ.1638* **44** 1–105

[5] Hollnagel E, Wears R L and Braithwaite J 2015 From Safety-I to Safety-II : A White Paper From Safety-I to Safety-II : A White Paper Professor Erik Hollnagel University of Southern Denmark , Institute for Regional University of Florida Health Science Center Jacksonville , United States of America Prof

[6] Hollnagel E 2012 *FRAM: the Functional Resonance Analysis Method* (England: Ashgate)

[7] Hollnagel E, Laursen T and Sørensen R 2022 A day when (Almost) nothing happened *Saf. Sci.* **147**