



Personal Identification (PIN) Safe Model to Analyze Unsafe Actions that Characterize Maritime Accidents

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論文内容の要旨

Summary of thesis

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専 攻 MARITIME SCIENCES

論文題目 (外国語の場合は、その和訳を併記すること。)

Personal Identification (PIN) Safe Model to Analyze Unsafe
Actions that Characterize Maritime Accidents

(事故原因の解析に基づく海難分析に関する研究)

指導教員 Prof. Dr. Capt. Masao FURUSHO

SUMMARY

This research focuses attention on safety challenges in maritime accidents, as basic of conditions unsafe actions of the human factor. Analyzing data is based on report from JTSB (Japan Transport Safety Board) during 1991-2008. Unsafe actions conditions is condition that occurred because of two possible events, i.e. substandard practices of human and substandard working of human or combination of both. It will be leading to deviations, undesired result. It means human error. The deviations of human error will become as hazard or risk. Any kinds of risk have consequences to incident or accident.

There are two major subdivisions of unsafe conditions (preconditions): substandard conditions of the operators and the substandard practices they commit. Substandard conditions are broken down from attribution of causes interacting with adverse mental states, adverse physiological states, and physical/mental limitations. The limitations are unsafe actions or unsafe condition. Types of substandard practices are making decisions. The start of every decision is making a procedure for the final choice output and that depends on the time limit and information. Generally, a dynamic situation becomes quite difficult for making decisions and taking action. Analyzing the subject matter will be helped comprehensively when investigating uses classification system or taxonomy error as a way of organizing performance. The taxonomies that emphasize observable behaviors are primarily of practical value.

Each of these subcategories is discussing in the model of the characteristic of the human element in analyzing data. Perceptions logic (AND/OR) is using in this research to help combination of both will happen that is developed by the author in this research (as showed in fig.1.3) which is integrated into a model called a PIN (Personal Identification) Safe model. Reliability of safety critical system is implemented in risks for human beings in its environment, such as unsafe actions in maritime accident. These people may interact with the system or not. In safety critical system, people need to be aware of these risks and know what to do in the case of problems. Based on these reason, Personal Identification (PIN) Safe model is done in logic perception of human beings.

In the result of this research to find out:

a. Identifying human elements in risk.

Identifying human elements is based on unsafe actions by root cause to determine any kind of maritime accident in risk. Any unsafe actions have different characteristics that lead to kind maritime accidents. The assessment step is applying in weight value as measures to determine the level of risk associated with a specific hazard. Result problems that the risk have reported in consequences level. Minimizing decrease of quality human performance as impacted unsafe actions is implemented 3A (awareness, action and attitude) behavior in part of PIN Safe model.

b. Improving quality of decisions in response unsafe actions

Quality of decisions is implemented actions that how to limitations of human element interacts with others system, particularly in maritime transport system. These elements are embedded in very complex, interdependent, and dynamic relationships. The maritime transport system is a very complex and large-scale socio-technical environment system consisting of human actions that interact with each other and operate in a physical environment in term man-machine-media and management. Knowing of working environment is one part to decrease the risk value of an individual ship. Every risk will reach to accident. Considering it has the probability accident which the ship determined time and location too. Analyzing effective and practice is counter measured for reducing the human elements involvement by studying the patterns that have the same value in error taxonomy that have been developed in order to get the performance shaping factors by PIN Safe model as anticipation of engineering controls.

c. Controlling the patterns of unsafe action in risk

Risk is the probability and severity of loss from exposure to the hazard. The accident probability for an individual ship is determined using so called "exposures" and a casualty rate. The exposures are the number of potential casualty sensitive situations in which the ship can be involved that could lead to an accident. This process define will be easier to recognize taxonomy errors in performance of seafarer. The probability of errors then severity of accident that could result pattern from the hazard based upon the exposures of personal within unsafe actions to hazard that anticipate about navigation problems as highest collision accident. There are expected of exposure as a key to develop human performance. During operational of workers will be affected by a given event or over time by repeated event.

d. Monitoring the patterns of unsafe action

Repeated event as unsafe actions is needed evaluation. Regarding these situation, the author has been researched method in controlling of taxonomy errors of unsafe actions till within 4M factors as comprehensive monitoring information processing in PIN Safe model. Those are needed for the role of management to evaluate. Strong management to evaluate event every characteristic of unsafe actions is important in establishing the evaluation strategies. Monitoring all factors, should be done to avoid critical situations aims to minimize human casualty. In chapter 5, got result about highest cases of human casualty come from unsafe actions such as improper management for ship operation, management of electrical equipment, improper handling and other task, improper of fishing work, poor management and passenger cargo loading, others, so keep continuous for specific training in limited time. Knowing kind of monitoring in unsafe actions can help to mapping features of limitations of human to get unique approach to improve human performance.

The summary dissertation has structure consist of:

In chapter 1, the background consisting of the reasons of the research issues is explained.

In chapter 2, the terms of safety in maritime systems are explained, along with the safety responsibilities within the industry of the international, regional, national and flag state regulations, and Port State Control (PSC). The emphasis is placed on the International Safety Management (ISM) Code, which provides the minimum standards and guidelines for operational safety management as related to the maritime system. The maritime system is interconnected with 4M (Man, Machine, Media and Management) factors which covered the four pillars of basic safety of critical situations. Clearly, the human elements are identified in maritime system as people abilities and limitations, the influences of man, machine media, and management: by the IMO and Anita Rothblum. Taking into account the characteristic of marine accidents, the human elements that are explored in this dissertation mainly focus on the unsafe actions of seafarers, and their underlying contributors such as the operators' personality that have a deep influence on the operator's performance. The external elements that are included are the environment, the society and ship itself, all of which that has direct contacts which are also deemed to be aspects of the human elements.

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In chapter 3, the theories of accident causation descriptions are prevented by identifying the root causes of maritime accidents. These are derived from persons who are familiar with accident investigation techniques. These methods are based on the management model (Henrich's Model) and of behavior models (human error, human factors, and human elements). Collaboration activities are directed to control of unsafe personal performance on certain knowledge, attitudes and abilities. The chapter describes about the accident causation theories. The importance of understanding the accident causation theories is illustrated in the maritime system by appreciating how unsafe actions in the construction workplaces model cause losses through safety response.

In chapter 4, the newly created Personal Identification (PIN) Safe method model, which integrates unsafe actions in the design of safety critical systems, is shown. Strong management to identify every characteristic of unsafe actions is required to establish the evaluation strategies. The PIN Safe model is a counter measure to devise a systematic identification of substandard, unsafe actions and critical events associated with characteristic accidents on the ship. The PIN Safe model in anticipation of engineering controls includes anticipation of all human factors. Initiating events as unsafe actions will lead to process deviations. Measurement parameters in all operations by approaching logic perspective can help to suggest improved motivation of self and censoring of equipment by ergonomics design it is useful to help to reach good performance in the working environment.

In chapter 5, the identification of unsafe actions in risk management is recognized as unsafe actions in features of human elements. There are many unsafe actions that lead to due failures, such as improper look-out, fatigue, no indication of navigation lights and shapes, signaling failures, improper ship's speed, ignoring of COLREGS, main engine failure, etc. The initial investigation is begun to study unsafe actions (as seen in fig 1.1 and 1.2) in order to know the risk of every unsafe action. All unsafe actions have different characteristics with the resulting consequence that maritime accidents occur.

In chapter 6, the human performance of the seafarer's behavior is analyzed in reference decisions making. Using logic perception in weight value, there are analyzed the interactions of unsafe actions by taxonomy of error modes, such as control failure, omission or repetition, reversal, too fast, too slow, too early, too little, too much, wrong input and miss-calibration associated with various scenarios within relations the relationships of the four factors of 4M (Man, Machine, Media and Management). The

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human elements factors found by patterns of unsafe actions in maritime accidents present the causes and probabilities of future accident.

In chapter 7, the consideration and conclusion are implemented to show the results of research in all previous chapters. The results show how the human elements' unsafe actions interact with equipment and other systems. They show that in decision making anyone has limitations according to their own characteristics which can introduce unsafe actions. They show that a strong management is needed as well as good monitoring and control of the operation in breakdowns of both equipment and of the safety culture required of all parties. The evaluation assessment that will be reached to improve safety culture at sea and the further researches is shown.

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論文 題目	Personal Identification (PIN) Safe Model to Analyze Unsafe Actions that Characterize Maritime Accidents (事故原因の解析に基づく海難分析に関する研究)		
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要 旨

本論文は、国土交通省の傘下であった海難審判庁（現：運輸安全委員会）が纏めた海難統計資料をもとに、海難原因をヒューマンファクターの観点から分析し、複雑な社会技術環境にある海事システム（船舶航行）の安全と海上災害の防止を目的とした研究である。

論文構成とその概要は次のとおりである。

第1章は、研究の背景及び目的を説明した後、研究方法及び各章の論文構成を述べている。

第2章は、安全の概念、海事における安全志向、特に SOLAS（海上人命安全条約）、STCW（船舶職員資格証明訓練条約）、MARPOL（海洋汚染防止条約）、ISM（国際安全管理コード）等の国際条約が採択された変遷を調査し、安全文化における人的要因に係る責任と4M要因に係る安全の考え方を確認している。

第3章は、事故原因を探るための事故発生理論について、人間行動を主眼とした人的要因の観点から論じている。身体的要因、生理的要因、心理的要因、社会心理的要因、そして人的要因の制約がもたらす人的要因から事故原因に潜む要因を探るための手法として、ハインリッヒ・ドミノ理論、スイスチーズモデル、事故根本原因追跡モデル（ARCTM）を用いている。

第4章は、一つ一つの海難原因が海難の種類に応じて異なることに着目し、人的要因が関係する海難ごとの特性を示している。そして、結果として生じる事態を Negligible・Minor・Moderate・Serious・Disastrous という5段階に区分し、同じく5段階に区分した海難の発生確率とのマトリクスを作成し、客観的なリスク判断の根拠を Negligible、Tolerable、Intolerable の3段階としている。その結果、Moderate と Serious な事態では、その殆どが容認できる範囲（Negligible & Tolerable）であると結論付けている。

第5章は、P&I, UK（英国船舶保険会社）が示したヒューマンエラー分類を発展させて作成した13個のコードと海難原因との組み合わせから、独自の海難データ解析手法を提示している。さらに、海難原因と4Mとのマトリクスから、海難審判庁が取り纏めた海難は、“不適切な見張り”や“疲労”が極めて特徴的な衝突海難原因であることを明らかにしている。

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第6章は、海事システムの安全性を高めるための方法として、PIN Safe (Personal Identification Safe) を提案している。これは、制御要因として Awareness (認識)、Action (行動)、Attitude (態度) の3つを考えている。次に、海難規模から多数の死傷者や被害を伴う大規模海難 (Major Accident)、海難審判所が対応する通常海難 (Minor Accident)、そして海難に至らないヒヤリハット (ニアミス: Near miss) という3つのリード要因を与え、海難の事実、4M要因、コード化したヒューマンエラー分類という3つの監視項目を提示することにより海上における安全文化の醸成を目指している。

第7章は、研究結果、考察及び結論を示し全体を総括し、今後の課題について言及している。

本研究の成果は、以下のとおりである。まず、PIN Safe(Personal Identification Safe) モデルを海事システムの安全性を高めるための方法として提案している。そして、海難資料の解析や海事社会の構成要素について、4M (Man・Machine・Media・Management) という要因を基軸にしながら PIN Safe モデルを開発し、導入したことは、独創性のある点として評価できる。また、海難原因に対する人的要因の割合が約40%であるというインドネシアの海難発生状況から推察すると、今後、PIN Safe 手法の導入による人的要因を主軸にした海難解析が必要と想定され、本研究の意義が期待できる。

このように、本論文は、研究内容の新規性、独自性及び博士論文としての体裁等の観点から博士（海事科学）の学位を得る資格を有すると認める。

本論文に関連する有審査論文は以下の2編（すべて第1著者、英文）であり、審査の要件を満たしている。

1. Haryanti Rivai, Masao Furusho, Strategic Identification of Unsafe Actions That Characterize Accidents on Ships, Korea Institute of Navigation Port and Research, Vol. 37, No. 5, pp. 499-509, (2013).
2. Haryanti Rivai, Kohei Hirono and Masao Furusho, Quantitative Model of Collision Causes in Japan. The Journal of Japan Institute of Navigation. Vol. 127, pp.125-132, (2012).

また、本論文の基礎となる参考論文には、以下の Proceeding papers (有審査) が以下に示す2編があり、いずれも国際学会において口頭発表したものである。

1. Haryanti Rivai, Masao Furusho, Shoji Fujimoto, Masaki Fuchi, Model of Human Elements for Maintenance Engineer on Maritime Field, IAMU 11, Conference Gdynia, Poland, pp.263-275, (2010).
2. Haryanti Rivai, Masaki Fuchi, Shoji Fujimoto, Masao Furusho, Analysis on Navigation Failures Being Causal to Maritime Disasters, ANC(Asian Navigation Conference), Wuhan, China, pp.371-382, (2011).