# The 4M Overturned Pyramid(MOP) Model Development to Characterize Accidents in Maritime Transportation System

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# 論文内容の要旨

氏　名　Wanginingastuti　Mutmainnah

専　攻　海事科学専攻

論文題目（外国語の場合は，その和訳を併記すること。）

The 4M Overturned Pyramid (MOP) Model Development to Characterize Accidents in Maritime Transportation System

(海上輸送システムにおける海難分析のための MOP モデル開発)

指導教員　古莊　雅生　教授

（注）2，000字～4，000字でまとめること。



The number of ships has increased, on average, more than 1.5% per year. At the end of 2016, the number of ships around the world was 91,000 [UNCTAD, 2017]. The investigation institutions of European Union (EU) Member states form the European Maritime Safety Agency (EMSA) to keep track of all marine casualties and incidents every year. In order to do this, EMSA created the European Marine Casualty Information Platform (EMCIP) and now publishes an annual report of its findings. In 2014, EMSA received 3,025 accident and incident reports (reported occurrences) that involved 3,399 ships [EMSA, 2015]. This number was an increase from 2,767 reports in 2013, and the increase number is believed to be caused by improvements in reporting.

In Japan, in 2014, there were 688 accidents, and in 2015, 793 accident investigations were launched (JTSB, 2016). The number of investigation reports increased just as it did at EMSA. Nowadays, accident investigation boards in each country have realized importance of collecting accident reports and are making improvements in collection. In line with these efforts to gather accident reports, analyzes is also being better developed. In this current research, the author develops a new model, the 4M Overturned Pyramid (MOP) Model, to characterize the various accidents. The characteristics found by this model are based on a list of causative factors and causative chains for each country, ship type, accident type, etc. depending on the needs of the inquiry.

MOP Model is developed by combining the Septigon model (society and culture, physical environment, practice, technology, individual, group, and organizational environment network) created by Grech et al. [Grech, Horberry, Koester, 2008] and the IM model proposed by Furusho [Furusho, 2013, 2000]. The IM model consists of 4M factors (man, machine, media, and management) that are connected by the individual element (I) as the core of the system. The MOP model is drawn as a three-dimensional relationship that appears as a three-sided inverted pyramid, where each corner of the pyramid represents one 4M factor. Each corner (factor) is connected to and affects the other factors.

The man factor should always be at the bottom of the inverted pyramid because it is the intrinsic factor that significantly affects all other factors. Because the model is drawn three-dimensionally as a three-sided inverted pyramid, it has four corners representing the 4M factors, and six edges representing interaction between the two factors that are connected by the edges. The edges, which are called line relations, show that the system is the result of interactions among the 4M factors. Thus, to obtain a safe system, all corners and edges should be reliable and balanced.

The corners and edges in the model are representatives of stakeholders of Maritime Transportation System (MTS) that contain not only the construction of the ship, but also many stakeholders involved. This system called as Socio-Technical Environment (STE).
This dissertation provides a new model, MOP model, is developed to characterize several accidents from the chain of failure. The final outcome of this model is causative chains of collisions.

The aims of this study are to find characteristics of accidents using data from Japan, United States (US), Australia, and United Kingdom (UK) and expand 4M (Man, Machine, Media, Management) concept into 4M Overturned Pyramid (MOP) Model that characterizes accidents as a chain of failures. This study re-analyzes accident investigation reports that are published by Maritime Transportation Safety Agencies (MTSAs) from each country in 2008-2013.

This dissertation has 7 chapters and is arranged as explained below.

Chapter 1 – Introduction
This chapter provides background why author carries out this research in detail, objectives, methodology and a brief explanation how the dissertation is made. The chapter construction is also provided in this chapter to make reader easier understanding what is inside this book.



Chapter 2 – Maritime Transportation System and Accidents
This chapter presents a literature review about MTS and maritime accidents. Definition of several terms that are related to this study is also provided here to make reader easier distinguish the different terms. Three main models of accidents are provided here including the definition of accident types.

Chapter 3 – 4M Overturned Pyramid (MOP) Model
This chapter outlines the original aspects of this research, the MOP model. Started from explanation how the MOP model is made up, the definition of the elements, the steps, to apply this model, to characterize accidents are also defined, and the development of the model year by year.

Chapter 4 – Accident in several countries analyzed by MOP model
This chapter applies the MOP model to collision accidents in Japan, Australia, UK, and US. The detail step of the MOP model is explained here from the causative analysis until line relation analysis. It provides the outcome from each step of MOP model, causative factor and causative chain lists. However, the detail step how the list of causative factors found is written in Appendix B. The comparison results from corner analysis are provided in occurrence ratio so then the comparison is not done only by the number of failures for each causative factor but also considered the total number of all failures occurred in each 4M factor in the country. From here, reader can easily see the characteristic of the collision in a country.

Chapter 5 – Specific topics
The previous chapter applies the MOP model to general purpose of characterizing the accidents. This chapter presents a deeper analysis utilizing MOP model for specific cases of time occurrence classification and improper look-out. The data is collision in Japan. The corner analysis and line relation analysis here are modified based on the need. The failures listed in causative factor list are divided based on time occurrences, day, night, and twilight. The more detail improper lookout occurred in Japan are also broken down in this chapter. The causative factors that are causing and caused by improper lookout are also showed here.

Chapter 6 - Summary of the analysis and discussion

It summarizes the analysis and discussion gotten from result in chapter 4 and chapter 5. This chapter provide the discussion of the most common causative factors that has outstanding number in each M factor as well as its causing factors. In total, there should be 4 point discussions because each point represents the most outstanding number of failures in each M factor. However, in man factor, there are two causative factors that have highest number of failures, thus there are 5 points discussed here. They are Careless from seaman in maintaining proper lookout (M101-02), Careless from seaman in monitoring/identifying any accident risk (M101-03), Equipment failure: AIS/ radar could not show information (M201-01), Busy traffic (M301-01), Poor management from onshore in identifying/ monitoring/ communicating any risk accident (M405-01).

Chapter 7 - Conclusion

It concludes all the analysis and discussion with an explanation of the reliability of the MOP model for use in characterizing maritime accidents. The conclusion that is gotten are:

1. The dominant factor leading to collision is man factor (M1)

In general man factor is still act as the main CF of accident, it is supported by the result of analyzed accident report shown the biggest number of failure in MOP model`s CA is on man factor. And the most significant factors from man factor are “Careless seaman in maintaining proper lookout” and “Careless seaman in monitoring/identifying any accident risk”, both CF are classified as “Careless Seaman”. In Machine factor, the most common CF is “Equipment failure: AIS/radar could not show information”, in Media factor is “Busy Traffic”, while in Management factor, “Poor management from onshore in identifying/ monitoring/ communicating any accident risk”.

2. MOP model is one of choice to analyze accident because of its flexibility

As the simple approach, this model can be utilized by organization/company to get the tendency how their accident occurred and modified based on their needs. This flexibility will be the benefit because the researcher can utilize this method started by generating the data needed.

（別紙１）

# 論文審査の結果の要旨

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| 論文題目 | The 4M Overturned Pyramid(MOP) Model Development to Characterize Accidents in Maritime Transportation System<br>（海上輸送システムにおける海難分析のためのＭＯＰモデル開発） | | |
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要旨

概要

MOP（4M Overturned Pyramid）モデルという海難分析のための新たな解析手法を提案する独創的な研究論文である。この海難原因を解析するモデルは、失敗や過失の連鎖から導出される海難原因を特徴付けるために発想されたモデルである。日本、英国、米国そしてカナダの海難データを用いて、従来から用いられている海難要因の４M、即ち Man（ひと）、Machine（もの）、Media（まわり）、Management（しくみ）という４つの要素を、要素自体(コーナー分析)と要素間の関係(ライン分析)からあらためて海難原因を特徴付けようという狙いがある。データは、前述の４か国がそれぞれ公表する日本の JTSB (Japan Transportation Safety Board)、米国の NTSB (National Transportation Safety Board)のような政府組織の運輸安全委員会が公表するデータを利用している。

論文は以下の７章で構成され、独自のモデル開発によって海難分析を進める研究展開になっている。

第１章　緒言

研究の着想に至った背景、目的、手法を述べ論文内容の概要を示している。そして、論文構成の概要を示しながら各章の展開を説明している。

第２章　海上輸送システムと海難

MTS(Maritime Transport System：海上輸送システム)と海難に関する先行研究を示している。この論文で用いる用語の定義を明確に示し、異なる用語の意義と理解に齟齬を生じないように工夫している。代表的な３つの海難事例を説明しながら、４Mで捉えられる海上輸送システムの特徴と４Mの観点に基づく海難発生の関係を探っている。

第３章　MOPモデル（4M Overturned Pyramid：MOP）

本研究のベースを構成する独創的なMOPモデルを説明している。MOPモデルを構成する要素（エレメント）から説明し、モデルの発展段階（ステップ）、モデルの適用、海難の特徴付けを示しながら、経年的なモデルの発展過程を説明している。

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第４章　MOP モデルによる海難分析

英文による詳細な海難レポートが得られないため、調査されていないアフリカを除く各地域における代表的な海難事例が得られた日本、オーストラリア、英国、そして米国で発生した船舶衝突海難に MOP モデルを適用して解析している。MOP モデルは、そのモデルが適用される段階的な説明と原因分析から要素間のライン分析までを示す一般的な手法として述べられている。

第５章 MOP モデルの海難への適用

時間経過的な海難事例や見張り不十分と判断される海難について、MOP モデルを適用した事例に基づいて詳細な解析を示している。特に日本で発生した衝突海難の事例を示しながら、モデルを適用する信頼性を高めている。

第６章　考察

第４章と第５章の論点を極め、M の要素で示される４つの要因と“ひと”に関わって追加される１つの論点という計５つの要因が、海難要因のポイントとして示され、考察の主軸を構成している。

第７章　結論

MOP モデルの信頼性を説明する結論である。その中心的な論点は、Man factor すなわち人的要因が最も関係する要因であることを示している。さらに『適切な見張りの維持の欠如』と『あらゆる状況に対する危険予測の欠如』は、主要な２つの原因として示される海技者の資質欠如であると結論づけている。

研究成果は、本論文を構成する主な投稿論文として、以下に示す３編の査読付ジャーナル論文として公表されている。


(1) Wanginingastuti MUTMAINNAH, Masao FURUSHO: 4M Overturned Pyramid (MOP) Model Utilization- Case Studies on Collision in Indonesian and Japanese Maritime Traffic Systems (MTS), TransNav, the International Journal on Marine Navigation and Safety of Sea Transportation, Vol. 10, No. 2, pp. 257-264, 2016.

(2) Wanginingastuti MUTMAINNAH, Achmadi Bambang SULISTIYONO, and Masao FURUSHO: Introducing 4M Overturned Pyramid (MOP) Model to Analyze Accidents in Maritime Traffic System (MTS): A Case Study on Collisions in Japan Based on Occurrence Time, Applied Mechanics and Materials, Vol. 862, pp. 220-225, 2017.

(3) Wanginingastuti MUTMAINNAH, Ludfi Pratiwi BOWO, Achmadi Bambang SULISTIYONO, and Masao FURUSHO: Causative Chain Difference for each Type of Accidents in Japanese Maritime Traffic Systems (MTS), TransNav, the International Journal on Marine Navigation and Safety of Sea Transportation, Vol. 11, No. 3, pp. 489-494, 2017.


本研究は、MOP（４M Overturned Pyramid）モデルという海難原因を解析するための新しい手法を提案するものである。海難原因を特徴付けるために、要素自体(コーナー分析)と要素間の関係(ライン分析)からあらためて海難原因の関係を解き明かそうと試みている。日本、オーストラリア、英国、米国の各国政府関係機関が公表する海難データをもとに MOP モデルを利用して得られた「適切な見張り」と「危険予測」の重要性は、海難原因における人的要因の重要性をさらに強調するものとして価値のある集積である。

提出された論文は海事科学研究科学位論文評価基準を満たしており、学位申請者の Wanginingastuti Mutmainnah は、博士（海事科学）の学位を得る資格があると認める。