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Maritime Investigation Reports Involving Man-Over-Board (MOB) Casualties: A Methodology for Evaluation Process

Denize Adam Düşme (DAD) Kazaları İçeren Deniz Kazası İnceleme Raporları: Bir Değerlendirme İşlem Yöntemi

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ABSTRACT

Flag states must issue their maritime investigation reports in accordance with the International Maritime Organization (IMO) circulars with the inclusion of 'lessons learned' items from recorded accidents or incidents. To identify the root cause of an event, there must be enough detail of information about the investigated event presented in reports. The information included in reports may help identifying the procedural deficiencies or technical challenges. Considering the Man-Over-Board (MOB) events as a sub group of maritime accident investigations, authors systematically reviewed over 100 reports containing MOB events in this study.

In this study, reports are reviewed and major differences in formats as well as level and type of information are recorded. A systematic methodology for reviewing and reporting the overall information retrieved from maritime accident reports is presented. To cover all information from reviewed reports, 113 information items are identified. An associated standard form is developed for use in extracting information from all investigation reports. Enabling the data collected systematically from reports, issued by the world maritime accident reporting states and agencies, and successively populated into a database for overall analysis, this form is called "Maritime MOB Events Investigation Form (MEI Form)". This paper presents the content of the MEI Form and demonstrates the methodology of use for retrieving, formatting and analyzing the information from the MOB investigation reports using case examples.

Keywords: Maritime Accident Investigation, Casualty Investigation Code, Man Over Board (MOB), Lessons Learned, Database, Data Format, Report Forms.

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ÖZET

Bayrak devletleri, deniz kazaları inceleme raporlarını Uluslararası Denizcilik Örgütü (IMO) genelgelerine uygun olarak ve kaza veya olaylardan öğrenilen dersleri içerecek şekilde yayınlamak zorundadırlar. Bir olayın kök sebebinin tanımlamak için ve bu nedenle raporlardan "Çıkartılan Dersler" dâhil edebilmesi için, sunulan raporlarda araştırılan olay ile ilgili yeterli bilgi detayı olması gereklidir. Raporlarda yer alan bilgiler olay esnasında yapılan işlemlerdeki eksikliklerin veya oluşan teknik zorlukların belirlenmesine yardımcı olabilir. Bu çalışmada, Denize Adam Düşmesi (DAD) olayları deniz kazaları araştırmasının bir alt grubu olarak değerlendirilmiş ve DAD olaylarını içeren 100'den fazla rapor sistematik olarak gözden geçirilmiştir. İncelenen raporlarda, format ve bilgilerin yanı sıra bilgi içeriklerinde de önemli farklılıkların olduğunu tespit edilmiştir.

Bu çalışmada, deniz kazaları raporlarından elde edilen genel bilgilerin gözden geçirilmesi ve raporlanması için sistematik bir yöntem sunulmuştur. İncelenen raporlardaki tüm bilgileri kapsayacak şekilde 113 bilgi maddesi tanımlanmıştır. Tüm araştırma raporlarından bilgi çıkarmada kullanmak amacıyla bir standart form oluşturulmuştur. Dünyada deniz kazalarını rapor eden devletler ve ajanslar tarafından yayınlanan ve genel analiz için bir veri tabanına yerleştirilen raporlardan sistematik olarak toplanan verilerin sağlanması için kullanılacak olan bu form "Denizcilik DAD Olayları İnceleme Formu (DAD Form veya MEI Form)" olarak adlandırılmıştır. Bu çalışmada DAD Formunun içeriği tanımlanmış, oluşturulan bu formlar kullanılarak araştırma raporlarından bilgi derlenmesi, formatlanması ve analiz edilmesi amacıyla olay örnekleri ile birlikte sistematik kaza inceleme yöntemi gösterilmiştir.

Anahtar sözcükler: Deniz kazaları İnceleme, Kaza İnceleme Yönetmeliği, Denize Adam Düşmesi, Öğrenilen Dersler, Veri Formatlanması, Rapor Formatı.

1. INTRODUCTION

International conventions, such as the Safety of Life at Sea (SOLAS) (URL-1, 2019), the Maritime Pollution Act (MARPOL) (URL-2, 2019) and the Load Line Convention (Contracting Governments, 1966), introduce liability and responsibility of casualty investigations assumed by the flag states. Therefore, flag states must prepare accident or incident reports and share findings as mandated by these international agreements. An international convention (United Nations, 1982) clearly states that flag states are required to carry out an inquiry for the ships sailing under their flag at open seas. The IMO adopted the Casualty Investigation Code (CI Code) (IMO MSC, 2008a) in the year 2008 in order to set an international standard for conducting the safety investigations and reporting. This code brings liability to very serious marine casualties. While MSC brings responsibility for the investigation of very serious marine casualties, the Maritime Labor Convention (MLC) additionally introduces flag states to investigate serious marine casualties (ILO, 2006). In order to classify a marine casualty as 'very serious marine casualty', the incident must involve; 'the total loss of the ship or death or severe damage to the environment (URL-3, 2019).

CI Code also clearly states that the objective of a marine safety investigation is 'preventing marine casualties and marine incidents in the future' (IMO MSC, 2008b).

It also states the inclusion of 'the identification of causal factors and the making of safety recommendations' as necessary and yet 'the reports must be provided to the Organization to enable wide dissemination of information to assist the international marine industry to address safety issues' (IMO MSC, 2008a).

A marine safety investigation report is written as a result of a marine safety investigation that must contain certain information, such as basic facts about the casualty or incident, relevant details about the ship, and narrative detailing of the incident or marine accident (IMO MSC, 2008a). Casualty investigation reports including such information are submitted to the IMO Secretariat by the member flag states. IMO has a designated group called Correspondence Group on Casualty Analysis and this group reviews the submitted reports according to the guidelines included in a document called Casualty Analysis Procedure (URL-4, 2019). This group drives important information from casualty investigation reports, such as the analysis and lessons learned information, which is published for the maritime community. In this study we studied the investigation reports and identified several inconsistencies in presentation of the data as well as missing information.

In current practice, MSC recommends root-cause analysis performed in the investigations; however, there is no guideline provided. In literature, according to comparison criteria (Gano, 2007), an effective Root Cause Analysis process compares the six generalized criteria. There are several methods for analyzing the root causes of an accident/incident. Arslan (2011), listed main root cause analysis methods (Arslan, 2011) for chemical tanker management as; FTA (fault tree analysis), ETA (event tree analysis), FMEA (Failure Mode and Effect Analysis), What/If Method, HAZOP (Hazard and Operability Analysis) and SWOT-AHP. According to a study, there are 20 different accident analysis methods; however, the most commonly used ones are fault tree analysis and Pareto analysis.

Kececi (2015) developed and presented criteria, with 18 items, as conditions for appropriate application of the root cause analysis of marine accidents. Akyuz and Celik (2014a) proposed an investigation model to apply to marine accidents that may help identify and reduce human errors in marine accidents (Akyuz and Celik, 2014b). Their study included a man overboard situation during a lifeboat drill, chosen as a novel case for their model demonstration. So far, there are no proposals in literature for the standardization of the investigation forms to use or process the current data other than what is laid out by current procedures issued by the IMO. Current IMO procedures seem to be generic, which is causing inconsistencies in formats between reports. Additionally, inconsistencies in reports result in a big yet unstructured data being used by the maritime agencies as well as academia. Some of the other studies about marine casualty investigation and CI Code focus on limited aspects of casualty investigation and proposal for use in local regions (Lim, 2010). Schröder- Hinrichs (2011) studies Accident investigation reporting deficiencies related only to organizational factors limited only with machinery space fires and explosions (Schröder-Hinrichs, 2011). Some of these studies are centered on general casualty investigation for a specific event, however, these studies are not focused on the use of the IMO casualty investigation code. For example, Moradi *et al.* (2014) proposes a fuzzy model for Iranian marine casualty management and Fukuoka (2016) studied the relationship between latent conditions and the characteristics of holes in marine accidents based on the Swiss cheese model. Another perspective of maritime casualty reporting is the data being publicly available and structured such that agencies of academia may digitally retrieve and conduct analysis. The methodology introduced in this paper provides a methodology of

structuring the data and sharing the information using a proposed form for enabling automated processes for analysis. With this approach, lessons learned based on statistics from the world's reported MOB events may easier be driven. Therefore, this methodology may be viewed as the first step definition and guidance for automating the lessons learned process for better understanding the areas for procedural improvements or introducing new techniques and technologies.

The most important outcome of maritime accident reports is the lessons learned and sharing this outcome with maritime user's community and technology developers. Weber *et al.* (2000), defines tasks in lessons learned process as; collecting, validating, storing, disseminating, and reuse. Weber *et al.* (2000) lists various methods of lessons learnt systems and proposes a system called 'Active Lessons Delivery System (ALDS)' (Weber *et al.*, 2000). Such studies point out that there is a wide range of lessons learned processes and procedures. However, for driving lessons learned information from marine casualty investigations, specific procedures and processes are yet to be described.

The outcome of this study is the proposed use of the form, MEI Form, which is specific to the MOB event reports. It may be viewed as guidance for automating the information acquisition and formatting the reports for driving a more structures process for driving lessons learned from MOB cases. World maritime investigation agencies can also use the proposed MEI Form as guidance in standardizing their data collection process.

2. CURRENT METHODOLOGY EMPLOYED IN MARITIME ACCIDENT REPORTING

2.1. Process for Maritime Accident Investigation Reporting Involving MOB Events

According to IMO Maritime Safety Committee Regulation (IMO MSC, 2008a), a marine safety investigation report is written as a result of a marine safety investigation which must contain the following specific information:

- a **summary** outlining the basic facts of the marine casualty or marine incident and stating whether any deaths, injuries or pollution occurred as a result
- the **identity** of the flag State, owners, operators, the company as identified in the safety management certificate, and the classification society (subject to any national laws concerning privacy)
- where relevant the **details** of the dimensions and engines of any ship involved, together with a description of the crew, work routine and other matters, such as time served on the ship;
- a **narrative** detailing the circumstances of the marine casualty or marine incident;
- analysis and comment on the **causal factors** including any mechanical, human and organizational factors;
- a discussion of the marine safety investigation's findings, including the identification of **safety issues**, and the marine safety investigation's **conclusions**; and
- where appropriate, **recommendations** with a view to preventing future marine casualties and marine incidents.

For further review and analysis of these reports focusing on events involving casualties, these reports are reviewed by various different groups of the IMO according to the guidelines included in a document called Casualty Analysis Procedure. Figure 1 shows the details of this process. In this process, IMO Casualty Analysis Working Group (CAWG) drives out the following information from casualty investigation reports (URL-4, 2019):

- the analysis of casualty report
- draft lessons learned for presentation to seafarers;
- potential safety issues, when appropriate; and
- draft safety recommendations, when appropriate.

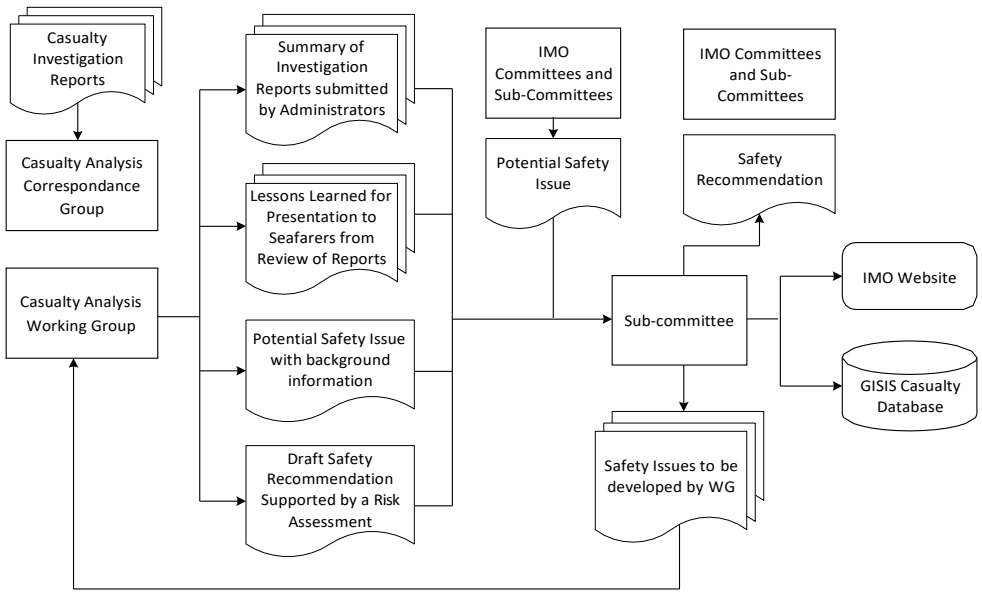

Figure 1. Graphic Representation of a Typical Flow of Casualty Information (URL-4, 2019) (redrawn for clarity).

2.2. Investigation of Current Maritime Safety Reports

Authors accessed to IMO's public database, called Global Integrated Shipping Information System (GISIS) (URL-5, 2019), and studied the current maritime safety reports and relevant publications. Until 31.12.2018, there have been 3876 recorded incidents categorized as 'very serious' in the IMO database with 1603 of these incidents having maritime safety reports. Table 1 shows the number of reports submitted to IMO by some of the Flag States and populated on the IMO website. The countries with the highest submission records are also shown. Table 1 includes both "total number of 'very serious incidents'" and "with public investigation form", respectively, reported to IMO for the ships under Flag of the mentioned state. As these are involving ships with the respective Flag State, some of these investigation reports might be a submission by other countries.

So far, authors found 24 'Lessons Learned' documents in different formats published by IMO in English (URL-6, 2019), 13 of which is found published in French (URL-7, 2019) and 15 of which is in Spanish (URL-8, 2019). However, up to date, there are 3100 reports are submitted in the GISIS website (URL-5, 2019) This may be an indicator for that the GISIS website could announce not many lessons learned items, using the current process.

For better understanding the content of current submitted reports with MOB involvement, authors studied and evaluated more than 50 reports and selected seven reports randomly among the collected reports, Table A.1 (Appendix A) lists the specifics about these reports and Table 2 presents an overview of these reports, as a case study and presentation. The first 7 rows in Table 2 include the information required by CI Code (IMO MSC, 2008b), listed in the previous section, and the next four rows provide the total number of information available in the pertaining report, shown in the next seven respective columns. Some of the reports included very little information, as specified in the CI Code and listed in Table 2; therefore, those reports were purposely discarded for use in this study for presentation. Table 2 gives some ideas about total pages, what type of information included and the total number of words used in the reports, yet it does not provide enough detail for what specific information and how much detail is provided. This and several

other issues noted when reviewing these reports are, for example:

- Report No 5 provides four recommendations while Report No 7 provides only one.
- All recommendations were for different targets. For example, one recommendation was for 'the Ministry of Health Care Services' while several recommendations were reminding notes on 'Code of Practice on Safety Standards for Class II Vessels.
- CI Code clearly states that, an investigation report must contain, 'where relevant the details of the dimensions and engines of any kind of ship involved.' One report provides detailed information about the relevant engine details whereas another report gives only engine power and one other includes no engine information.
- Additionally, the format of the content between the reports is inconsistent; yet there is no tool to identify this observation by measurable methods.
- The total number of pages used in several reports is a few pages, i.e. only 4 in one report, while some other reports are more than 30 pages.
- There are some reports with one or several missing information areas. For example, there is information in all of them about the narrative; however, specifying seven items in the contents does not indicate what detailed level of information exists.

Below is a summary of learnings that we obtained as the outcome of this study:

i. CI Code requirement gives a general idea about what must be the contents of an investigation report; however, it does not specify how the detailed contents should be. This may be because the investigation reports, in practice, are about specific subjects, such as ship accident and personal injury during work.

ii. CI Code's content recommendation is not specific for the MOB events. However, when a specific MOB event is studied from investigation reports, some specific information could be very important for understanding the procedures, techniques, and the root causes. In other words, these information are essential to include to identify tangible lessons learned items.

iii. For populating the report information such that those can be crosschecked through analysis tools from databases, the MOB reports should be structured accordingly, allowing the reports to have consistent formats. It would also allow statistical analysis of reports.

Table 1. Number of Investigation Reports Submitted to IMO by Major Flag States.

	Italy	Belgium	France	Japan	Turkey	Tunisia	US	Norway	Egypt	Brazil
Total very serious incidents	35	13	141	223	187	1	294	209	31	32
With public investigation form	6	4	71	50	14	0	13	18	5	8

Table 2. Review Results of Several Accident Investigation Reports According to Requirements of RESOLUTION MSC.255(84).

Report Number	1	2	3	4	5	6	7
Summary	√	-	-	√	√	√	√
Identities	√	√	√	√	√	√	√
Details	√	√	-	√	-	√	√
Narrative	√	√	√	√	√	√	√
Casual Factors	√	√	√	√	√	√	√
Discussions	√	√	-	√	√	√	√
Recommendations	-	√	-	√	√	√	√
Total Pages	8	8	4	17	35	33	11
Total Pages Without Cover Page	8	4	4	14	31	31	11
Total Number of Words (estimate)	3806	1738	1317	2433	12305	10468	4221
Percent Field Complete (estimate)	85,70%	85,70%	42%	100%	85,70%	100%	100%

3. INVESTIGATION OF MOB EVENTS FOR DEVELOPING THE MEI FORM

We studied the factors affecting a MOB event to start driving the required information that should be presented in investigation reports involving MOB events. Section 3.1 presents these factors with several examples from the studied reports.

3.1. Important Factors in a MOB Event

Detailed information is needed to understand all details associated with a MOB event. Initially, we made the following considerations to understand what areas of information should be included in the reports:

- What information is already requested by IMO
- The information areas missing in the reports for extracting lessons learned information
- Factors affecting the event is being initiated
- Factors affecting the development of the process negative or positively
- Techniques used during the response action
- Factors affecting the end result, which is casualties survival or ending with minimal health risks
- Information to derive should be standard such that it can be extracted and inserted into a database with appropriate tags.

Examples below provide an understanding of what detail level of information needs to be included in the reports.

Example 1: During cargo operation at port, a deck rating fell overboard resulting in a fatality on vessel Joanna (UK Inv., 2011). Even though there was an alcohol policy, the analysis of postmortem blood revealed that Stanislaw had a blood alcohol concentration of 93mg/100ml. There was a procedure but it was not applied properly. The casualty was not using proper safety equipment and there were no proper safety equipment onboard. From this event, the following questions were driven and added on the MEI form:

- Alcohol / Drug Influence; 'Describes the alcohol or drug influence of the casualty at the time of the event.'
- Working as per the safety rules; 'Was the work being performed as per the safety rules and instructions?'
- Workplace conditions as per the safety rules; 'Was the work conditions set as per the rules and safety instructions'

Example 2: Response actions and times are very critical when removing the casualty from the water. According to the report of MOB event onboard Hyundai Dangjin (Appendix A, Report No. 2), the casualty was alive when seen and became not meanwhile there was a removal procedure continuing. To understand the details of why the casualty could not survive, sea temperature and time of removal of the casualty from the water must be known, yet this information is not found in this report.

3.2. Factors Considered for Developing the Contents of the Proposed MEI Form

MOB event starts with the time of a person falling overboard and ends when the MOB response operation is terminated. There are many factors affecting a MOB event, for example, "how it occurred", "how it developed", "how it was responded", and "how it was terminated". To understand what specific details are associated, we reviewed over 100 reports and focused on the details of the information. Starting with the seven content items provided in CI Code, we studied over 100 reports and labelled information items with a unique code. There became 113 information fields identified in this study with unique codes assigned for each information item, as presented in section 4.

Using the evaluation of the reviewed reports as well as listed aforementioned factors, which are specific to MOB event information in reports, all information that can be found in reports was categorized as follows:

- Vessel Information
- Navigation Conditions
- Information about the Casualty/Casualties
- Meteorological Conditions
- Work Type and Conditions
- Managerial/Procedural Conditions
- Start of the Event and Initial Timings
- Response Times and Actions
- Search and Rescue (SAR) Operation
- Health Status of the Casualty
- Type of Recommendations

Breakdown of the above categories yielded in 113 information items with unique codes, shown in the sections of the MEI form, presented in sections below.

4. PROPOSED FORM

This section describes the contents of the MEI Form, proposed to use by Maritime Investigators when the investigation involves a Man-Over-Board (MOB) casualty. There is a group of 11 sub-categories with 113 form items under all categories in the proposed MEI Form. Each item has a unique identifier, named as 'Field Code', for future use in electronic form submissions into a database. The user could search the MEI Reports Database with the Field Code of the specific item and do analysis for one item or do a more complex analysis with correlation study.

Note: For the tables presented in this section, from table 3 to table 12, 'NA' means 'Not Applicable' and 'NI' means 'Not Indicated' in the report.

4.1. Vessel Information

This field group is to drive information from a report about the vessel, associated with the MOB event at the time of the event occurring. Table 3 shows the detailed contents of the Vessel Information to retrieve from reports with short descriptions for guidance.

4.2. Navigation Conditions

This field group is for extracting the navigation conditions under which the ship is navigating on the sea and /or what operations it is performing during the MOB event. Table 4 indicates the detailed contents of the 'Navigation Conditions' category of information to retrieve from reports.

Table 3. Proposed MEI Form: 'Vessel Information' Section.

Field Code	Field Name	Short Description /Guide
V01	Event number	Event investigation number, which is an identifier for the MOB event.
V02	Vessel name	Name of the ship recorded during the MOB event investigation.
V03	Flag	Registered flag of the vessel.
V04	Vessel type	For example, cargo ship, passenger ship, research ship, military ship, etc.
V04.1	Vessel sub category	G04.1 is a sub-category for the vessel type. For example, crude oil tanker, container, and bulk carrier fall under cargo ship sub-category.
V05	Age group	The age group of the ship's age. Age intervals mainly are as follows: 0-3, 4-6, 7-10, 11-15, 16-20, 21-30, 31+, or 'NI'. If the report does not specify, the difference between the MOB event date and ship's construction date is used.
V05.1	Exact age	Construction year of the vessel.
V06	Tonnage group	Gross Tonnage of the vessel, which specifies the predetermined tonnage range of gross tonnage of the ship. Tonnage intervals are: 0-49, 50-99, 100-299, 300-499, 500-999, 1000-1999, 2000-2999, 3000-4999, 5000-9999, 10000-49999, and 50000+.
V06.1	Tonnage (GRT)	The exact value of the gross tonnage recorded in the ship's registry.
V07	Length group	The following interval of the registered full length (LOA) of the vessel, in meters: 0-11, 12-19, 20-49, 50-99, 100-199, or 200+.
V07.1	Vessel length	The registered full length (LOA) of the vessel in meters.
V08	Vessel classification	The classification organization of the ship.
V09	Number of personnel	The number of personnel listed in the ship's log at the time of the MOB event. At ports or during anchorage, registered personnel or passenger's being out of the ship does not change this number.

Table 4. Proposed MEI Form: 'Navigation Conditions' Section.

Field Code	Field Name	Short Description /Guide
N01	Navigation status	Select 'Yes', 'No', 'NA' or 'NI' as an answer for the following question: 'Was the ship in navigation during the MOB event?'
N02	Operational state	The operational status of the ship during the accident. Enter Navigation, Port, Anchorage, Drift, Shipyard, In-Maneuver, Other, or 'NI'.
N03	Was the on-duty officer alone?	Select 'Yes', 'No', 'NA' or 'NI'. Note: Need to fill this item if S03 is one of the following choices: Navigation, anchorage, drift, In-Maneuver, or Other (the ship has way?). Otherwise, enter 'NA'.
N04	Who has the command-in-charge?	Indicates which one of the personnel had the responsibility of the ship at the time of MOB event: 'Watch keeping Officer', 'Ship's Captain', 'Pilot', 'No Command'. Note: Need to fill this item if S03 is one of the following: Navigation, anchorage, drift, In-Maneuver, or Other (the ship has way?). Otherwise, enter 'NA'.
N05	Distance to the nearest land	The distance, in nautical miles, to the nearest land part at the time of the event.
N06	Location	Preferably the latitude and longitude of the ship's location. If exact location is not available in the report, geographic name of the location is used.
N07	Ship's draft (m)	Draft of the vessel, in meters.
N08	Ship's speed (knots)	Ship speed, in nautical miles (knots). Enter: Ship speed value in knots, if the ship in navigation or "0" is the ship is anchored or at port

4.3. Casualty Status/Information

This section provides a piece of general information about the person(s) involved in the MOB event according to the studied report. It also helps to understand whether a person was under the influence of alcohol or drug recorded at the time of the event. Table 5 gives detailed information about casualty and his familiarization to ship.

4.4. Meteorological Conditions

This section of the form is to extract the environmental, especially meteorological conditions during the MOB event. Table 6 shows very detailed information about the meteorological conditions such as wind, visibility, rain, etc.

4.5. Work Type and Conditions

This section of the form is to extract the information about the work type and conditions during the MOB event. Table 7 describes if work type and place are compatible with safety rules.

4.6. Managerial/Procedural Conditions

This section of the form is to extract the documentation and process-related managerial/procedural conditions of the vessel, indicated in the event report. Table 8 gives very detailed information about managerial procedures and by examining this table, the root cause can be distinguished.

Table 5. Proposed MEI Form: 'Information about the Casualty/Casualties' Section.

Field Code	Field Name	Short Description /Guide
C01	Rank	Enter the rank or status of the casualty on-board ship. Captain, Deck Officer, Passenger, Other Service Personnel are some examples. "Integrated Rating" classification can be entered if the casualty's position is identified as both deck and engine personnel.
C02	Nationality	Nationality of the casualty.
C03	Age	Age of the casualty.
C04	Overall on-board work experience	Work experience of the casualty in years.
C05	Work duration (on-board Ship)	Work duration on-board the current ship of the casualty, in months.
C06	Alcohol/drug Influence	Describes the alcohol or drug influence of the casualty at the time of event. Select 'Yes', 'No', 'NA' or 'NI'.

Table 6. Proposed MEI Form: 'Meteorological Conditions' Section.

Field Code	Field Name	Short Description /Guide
M01	Adverse weather	Information to drive the weather conditions having any adverse effects on the MOB event. Information to consider in general are the effect of wind, sea waves, current, visibility, and temperature. Select 'Yes', 'No', 'NA' or 'NI'.
M02.1	Wind speed	Wind speed in 'beafort scale'.
M02.2	Wind direction	Wind direction in angle, as true direction.
M03	Sea scale	Sea Scale indicating the condition of sea waves, entered in 'beafort scale'.
M04.1	Sea current speed	Enter sea current speed in knots.
M04.2	Sea current direction	Direction of the sea current's angle, as true direction.
M05	Rain	Indicates the existence of rain or snow conditions during the event. Information to include rain, snow, slow rain, no rain, etc.
M06	Visibility	Indicates the visibility recorded at the time of the event. The information is entered as per the visibility scale from 0 to 8 or 'NI' is entered. If the reports states 'normal visibility', enter '6' for a neutral visibility level.
M07	Sea temperature	Sea temperature in Celsius (°C).
M08	Air temperature	Air temperature, in Celsius (°C).
M09	Sea depth	Sea depth in meters.
M10	Darkness	Indicate the weather being 'dark' or 'not dark'.
M11	Lightning conditions	Lightning conditions, recorded at the time of the event. Enter as follows: Yes: Enough light conditions No: Lightning is not enough
M12	Day/night	Enter 'Day-time' or 'Night-time' if additionally indicated in the report.

Table 7. Proposed MEI Form: 'Work Type and Conditions' Section.

Field Code	Field Name	Short Description /Guide
W01	Relevance to work	Information to drive whether the event was work related. Yes: Work related event No: Not a work related event During transportation: Both for passengers and for employees during their transportation to/from work. Enter 'NI' if no information found in the report.
W02	Working as per the safety rules	Was the work being performed as per the safety rules and instructions? Fill this section with a 'Yes', 'no', or 'NI. Example: The answer is 'No' when not wearing a life jacket where a person 'must' wear, at the time of the event.
W03	Workplace conditions as per the safety rules	Select 'Yes', 'No', 'NA' or 'NI' as answer to the following q: "Was the work conditions set as per the rules and safety instructions?". Example: The answer is 'No' when there is no life jacket available where there 'must' be, at the time of the event.
W04	Wearing a life jacket	Was the casualty wearing a life jacket (or personal floatation aid), as recorded at the time of the event? Select 'Yes', 'No', 'NA' or 'NI'.
W05	Alone	Information to understand if there was a secondary person (other than the casualty) witnessing the event. Select 'Yes', 'No', 'NA' or 'NI'.

Table 8. Proposed MEI Form: 'Managerial/Procedural Conditions' Section.

Field Code	Field Name/Short Description	Guide
P01	Applicable checklist	Is there a document requirement (checklist or form) before the work of which the event occurred? For example, a checklist must be filled at each time a work will be at the overboard. Select 'Yes', 'No', 'NA' or 'NI'.
P01.1	Checklist filled	If P01 cell is filled with a 'Yes', then this section is filled. Select 'Yes', 'No', 'NA' or 'NI'.
P01.2	Checklist filled properly	If P01.1 cell is filled with a 'Yes', then this section is filled. Select 'Yes', 'No', 'NA' or 'NI' depending on the checklist or form fulfilled properly as per the instructions.
P02	Applicable general work procedures	This section is to understand whether the safety instructions or procedures were described per the safety manuals. Select 'Yes', 'No', 'NA' or 'NI'.
P02.1	General work procedures implemented properly?	Select 'Yes', 'No', 'NA' or 'NI'. Note 1: If the result of the section P02 is a 'yes', then this section is to fill. Note 2: If the result of the section P02 is other than a 'yes', 'NA' is to enter in this field.
P03	Fatigue condition	This section is to extract information from the report for that there could be a fatigue situation involved with the casualty. Select a Standard Answer.
P04	Implementation of MOB drills	Was the MOB drills were carried out in required periods? Select 'Yes', 'No', 'NA' or 'NI'.
P05	Was there a SAR Procedure?	Select 'Yes', 'No', 'NA' or 'NI'.
P05.1	SAR Procedure implemented appropriately?	Select 'Yes', 'No', 'NA' or 'NI'. Fill this section only if the result of the section P05 is a 'yes'. Or, fill with 'NA'.

4.7. Start of the Event and Initial Timings

This section of the form is aimed to extract information about the MOB Event's Time and Initiation from the event report. In other parts of this study, this time is mentioned as T0. All other times are given as time passed from this moment. Table 9 gives information related to key elements and timings of the accident.

4.8. Response Times and Actions

This section of the form is prepared to extract information about the initial practices implemented for preventing a casualty or further damage. Table 10 gives information both if specific initial response actions were carried out and their timings if they were carried out.

4.9. Search and Rescue (SAR) Operation

This section of the form is targeted to drive information about the rescue operation, as indicated in the event report. Table 11 gives information about both search and rescue actions and their timings.

4.10. Health Status of the Casualty

This section of the form (Table 12) is to extract information about the health status of the casualty. Note that the investigator should fill all sections of the MEI Form separately for each casualty. Table 12 gives detailed information related to the health status of casualty.

4.11. Type (Category) of Recommendation

This section of the form is generated to extract recommendations properly from reports. Recommendations are categorized as 'Human', 'Management', and 'Equipment'. The form shown in Table 13 is used for extracting the recommendations with categorizations.

Table 9. Proposed MEI Form: 'Start of the Event and Initial Timings' Section.

Field Code	Field Name/Short Description	Guide
M01	Date	Date of the MOB event.
M01.1	Time	Time recorded for the man become overboard. Time format in formats, such as ZT, GMT or national time formats are all acceptable.
M02	Action causing the MOB event	The action casualty was performing when the MOB event occurred. Some examples: 'Rigging pilot ladder', 'engaging in fishing', 'slipping', 'hit by waves', 'extreme wind', 'intentional'.
M03	From where?	Information about from which part of the vessel, the casualty fall overboard. The following are the choices to enter: 'Forecastle', 'Starboard bow', 'Starboard', 'Starboard quarter', 'Aft deck', 'Port quarter', 'Port', 'Port Bow', 'Other', or 'No information'.
M04	Immediate/late awareness	Was the MOB event seen immediately by another person? Fill this section with an answer, namely, 'yes', 'no', or 'NI'.
M05	Latency	Minutes passed between MOB and the time that a person became aware of the situation.
M06	Assumed overboard	There are cases where man-over-board event is not witnessed but assumed with an investigation. Was the MOB event had to be the assumed? Select 'Yes', 'No', 'NA' or 'NI'.
M06.1	Decision duration	Minutes passed between the time of the actual event and the time the MOB event had to be assumed. Enter 'NA' if M06 is other than a 'yes'.

Table 10. Proposed MEI Form: 'Response Times and Actions' Section.

Field Code	Field Name/ Short Description	Guide
T01	Event notification to the bridge	When MOB event actual time is considered to be t0, enter the duration, in minutes, passed between t0 and the time of the event notified to the bridge (when in navigation) or cargo control station (during loading/unloading).
T02.1	Alarm	Enter the duration, in minutes, passed between t0 and the time of alarm.
T02.2	Announcement	Enter the duration, in minutes, between t0 and the time of internal announcement.
T02.3	Whistle	Enter the duration, in minutes, between t0 and the time of whistle.
T03	Buoy	Enter the duration, in minutes, between t0 and the time of throwing the buoy.
T04	Maneuvering	Enter the duration, in minutes, between t0 and the time of the start of maneuvering. For search and rescue events, generally 'Williams Turn' method is implemented. If the ship is not in navigation, enter 'NA'.
T05	Captain	Enter the duration, in minutes, between t0 and the time of the ship's captain gaining control over the situation.
T06	GPS MOB	Enter the duration, in minutes, between t0 and the GPS MOB system's activation time.
T07.1	Notification to close by ships	Enter the duration, in minutes, between t0 and the time of the notification broadcast to close by ships. Note: If the notification to the SAR stations performed with a VHF type general announcement, this could also be considered as the announcement to the close by ships.
T07.2	Notification to SAR stations?	Enter the duration, in minutes, between t0 and the time of the notification broadcast to the Shore or SAR stations.
T07.3	Other notifications	Enter the duration, in minutes, between t0 and the time of the notification to other organizations, such as ship operating company.
T08	Rescue boat is ready	Enter the duration, in minutes, between t0 and the time of the Rescue Boat is ready.

Table 11. Proposed MEI Form: 'Search and Rescue (SAR) Operation' Section.

Field Code	Field Name/Short Description	Guide
R01	Rescue boat	Was there a rescue boat utilized in the MOB event? Select 'Yes', 'No', 'NA' or 'NI'.
R02	Timing of rescue boat in water	Duration, in minutes, between t0 and the time of the rescue boat placed in water.
R03	Other ships	Was there other ships involving with the rescue operation? Select 'Yes', 'No', 'NA' or 'NI'.
R04	Timing of other ships	Duration, in minutes, between t0 and the time of the other ships joined in the rescue operation. Note 1: If there are more than one ship joined to the operation, the duration is for the first ship involved Note 2: If R03 is 'no', fill this with 'NA'.
R05	SAR ships	Was there SAR ships joined into the SAR operation? SAR ships are boats designed to operate only for SAR operations. Select 'Yes', 'No', 'NA' or 'NI'.
R06	Timing of SAR boats	Duration, in minutes, between t0 and the time of the SAR Boat joined in the SAR operation. Note 1: If R05 is 'no', fill this with 'NA'.
R07	Air operation	Was there Air Vehicles joined into the SAR operation? Select 'Yes', 'No', 'NA' or 'NI'.
R08	Timing of Air operation	Duration, in minutes, between t0 and the time of the Air Vehicle(s) joined in the SAR operation. Note 1: If R07 is 'no', fill this with 'NA'. Note 2: If there are more than one air vehicle, enter the duration for the first air vehicle.
R09	Shore assistance	Was there shore personnel or teams (such as ambulance and medical teams) joined into the SAR operation? Select 'Yes', 'No', 'NA' or 'NI'. Note: Enter 'NA' if the ship is not in port.
R10	Timing of shore assistance	Duration, in minutes, between t0 and the time of the Shore Assistance started in SAR operation. Note 1: If R09 is 'no', fill this with 'NA'. Note 2: If there are more than one team or person, enter the duration for the first team joined into the SAR operation.
R11	Casualty removed from the water	Was the casualty removed from water (regardless of survival status)? Select 'Yes', 'No', 'NA' or 'NI'.
R12	Removed by	Enter the team or personnel removed the casualty from water. Fill this item if R11 is 'yes' or fill with 'NA'.
R13	Timing of removal	Duration, in minutes, between t0 and the time of the casualty was removed. Note: Fill this item if R11 is 'yes' or fill with 'NA'.
R14	Cancellation of the SAR operation	Enter the reason which cancelled the SAR operation other than 'removal' of the casualty from water. Examples are: Shore authorities command/order Ship decision Heavy weather conditions Other No info
R15	Duration, cancellation of the SAR operation	Duration, in minutes, between the start and cancellation time of the SAR operation.

Field Code	Field Name/Short Description	Guide
R16	Limited Sighting of the Casualty in Water	Was there eye watch of the casualty, after the MOB, meanwhile the casualty in the water, for a limited time? Select 'Yes', 'No', 'NA' or 'NI'.
R17	Duration, limited sighting of the casualty in the water	Duration, in minutes, of the casualty was under eye watch. Enter a value if R16 is a 'yes' or enter 'NA'.
R18	Uninterrupted sighting of the casualty in water	Was there a continuous eye watch of the casualty until the end of the MOB operation? Select 'Yes', 'No', 'NA' or 'NI'.

Table 12. Proposed MEI Form: 'Health Status of the Casualty' Section.

Field Code	Field Name/Short Description	Guide
H01	Death	Enter the status of the casualty (Did the casualty die?). Fill this section with: 'yes: Death', 'no', 'NA', or 'NI'.
H01.1	Witnessing death	Was the death identified through a medical check, such as controlling the pulse or with a similar method? Select 'Yes', 'No', 'NA' or 'NI'.
H01.2	Decision for death	Was the death of the casualty the result of a decision, considering the conditions, such as seawater temperature, waves, during the operation? Select 'Yes', 'No', 'NA' or 'NI'. Note: If the casualty could not be found, as per the report, select 'Decision for Death'.
H01.3	Timing of death	Was the death before or after the end of SAR operation? Fill this section with a 'before', 'after', 'missing/assumed death', 'NA', or 'NI'.
H02	Cause of death	Fill this section if H01 is a 'yes' or, enter 'NA'. Some examples to enter are 'hypothermia', 'cardiac arrest', 'head injury', 'drowning'.
H03	Duration until death	Duration, in minutes, between t0 and the time of death. Fill this section with a 'yes', 'no', 'NA', or 'NI'. Note 1: If the report does not include this information, use the information in the death announcement. Note 2: If the casualty could not be found or not taken from the sea, enter 'not clear'.
H04	Rescue to death timing	Duration, in minutes, between the time of rescue and time of casualty's death. Note 1: Fill this section only if both H01 and R11 are 'yes'. Note 2: If the report does not include this information, use the information from the death announcement.
H05	First aid	Was there a first aid needed? Select 'Yes', 'No', 'NA' or 'NI'.
H05.1	Duration MOB to first aid	Duration, in minutes, passed between the MOB and first aid given. Note 1: Fill this section only if H05 is 'yes' or enter 'NA'.
H05.2	Duration rescue to first aid	Duration, in minutes, passed between the times of rescue of the casualty to the first aid started. Note 1: Fill this section only if both H05 and R11 are 'yes' or enter 'NA'.

Field Code	Field Name/Short Description	Guide
H06	First Aid at or by the medical facility (Shore side)	Was there a first aid performed by the medical care personnel (shore based), i.e. at an ambulance, hospital or at a health center? Select 'Yes', 'No', 'NA' or 'NI'.
H06.1	Duration, time passed until first aid given by at or by an established medical facility (shore side)	Duration, in minutes, passed between MOB time and time of first aid given by shore side medical care personnel. Enter 'NA' if H06 is not a 'yes'.

Table 13. Proposed MEI Form: 'Type of Recommendation' Section.

Field Code	Field Name/Short Description	Guide
L01	Existence of Recommendation	Fill this section with a 'yes' or 'no'.
L02	Number of Recommendation	Enter the number of recommendations indicated.
L03	Recommendation Cat I	Enter 'yes' if there is a recommendation in 'Human' category Enter 'no' if there is no such recommendation. 'Yes' would indicate at least one recommendation is made in this category.
L03.1	Content of Rec Cat I	Enter all recommendations as indicated in the report in 'Human' Category'.
L04	Recommendation Cat II	Enter 'yes' if there is a recommendation in 'Management' category Enter 'no' if there is no such recommendation. 'Yes' would indicate at least one recommendation is made in this category.
L04.1	Content of Rec Cat II	Enter all recommendations as indicated in the report in 'Management' Category.
L05	Recommendation Cat II	Enter 'yes' if there is a recommendation in 'Equipment' category Enter 'no' if there is no such recommendation. 'Yes' would indicate at least one recommendation is made in this category.
L05.1	Content of Rec Cat II	Enter all recommendations as indicated in the report in 'Equipment' Category.

5. BENEFITS OF USING THE MEI FORM

Appendix A shows the use of the MEI Form for extracting information from three different Investigation Reports. List of these three reports are as follows:

We noted benefits while implementing the MEI Form for these reports. This section summarizes the benefits of using the MEI Form with standard content and format, allowing the data from MOB investigations populated in a database, called the MEI database.

We were able to populate information from over 50 investigation reports with MOB events and derived many results. This paper's focus is to describe the MEI Form and discuss

the benefits; therefore, some of the benefits observed during this analysis and research study are reported and discussed in sections below. Further discussion on the analysis results will be issue of another report paper.

5.1. Obtaining Statistical Data

Using standard fields in digital forms populated in a database, statistical data can easily and accurately be driven. As an example, according to data provided by the Boat Owners Association of the United States Reports, U.S. boating MOB events between 2003 and 2007 (Edmonston, 2012):

- In deaths from MOB events occurring during day times, the rate of the casualties' being under the influence of alcohol was 27 percent. Whereas, the same rate was found as 50 percent at night times.
- 90 percent of events occurred in low weather conditions with wave height is less than one feet.
- 24 percent of the deaths were at night and 76 percent were during the day.

Academia and industrial researchers can easily generate similar statistical results using the data from a global perspective. Additionally, several parameters between the information across all reports could be analyzed for more elaborated statistical evaluations.

5.2. Providing Useful Data for Obtaining Lessons Learned

Very few of the current reports provide some lessons learned information which IMO Sub-committees are then can review and evaluate. However, the statistical results using the data can provide direct information as 'lessons learned'. For example:

- Alcohol has a very high (27 percent at day time, 50 percent at night time) in MOB casualties in boating events
- Influence of alcohol in MOB casualties at night time is nearly twice (1,852 times) a day.
- A great percentage (90 percent) of events occur in favorable weather conditions (wave height being less than 1 feet).

As well as providing useful data for obtaining lessons learned, standardized and digitized forms provide exact numbers and data instead of generic numbers.

5.3. Better Understanding of the Root Cause

In the MOB event of Graig Rotterdam, casualty fell overboard when cargo at deck collapsed. There was an applicable checklist titled; 'Refer to Log & Timber Cargo Operations Checklist'. The checklist was filled by the chief officer and verified by the master but no control measures were taken and the requirements of the checklist were matched. When the information is extracted from this report using the MEI Form, P01, P01.1, and P01.2 are the applicable fields and while extracting the information, the process is shown in Figure 2. To better understand this process, below mentioned three questions are taken from the proposed MEI form:

- P01 Applicable checklist; was there a document requirement (checklist or form) before the work of which the event occurred?
- P01.1 Checklist filled; if P01 cell is filled with a 'Yes', then this section is filled with a 'yes', 'no', 'NA', or 'NI'
- P01.2 Checklist filled properly; if P01.1 cell is filled with a 'Yes', then this section is filled. Fill this section with a 'yes', 'no', 'NA', or 'NI' depending on the checklist or form fulfilled properly as per the instructions.

Answers of these three questions are enough to distinguish that the root cause of this event is a human factor or managerial issue.

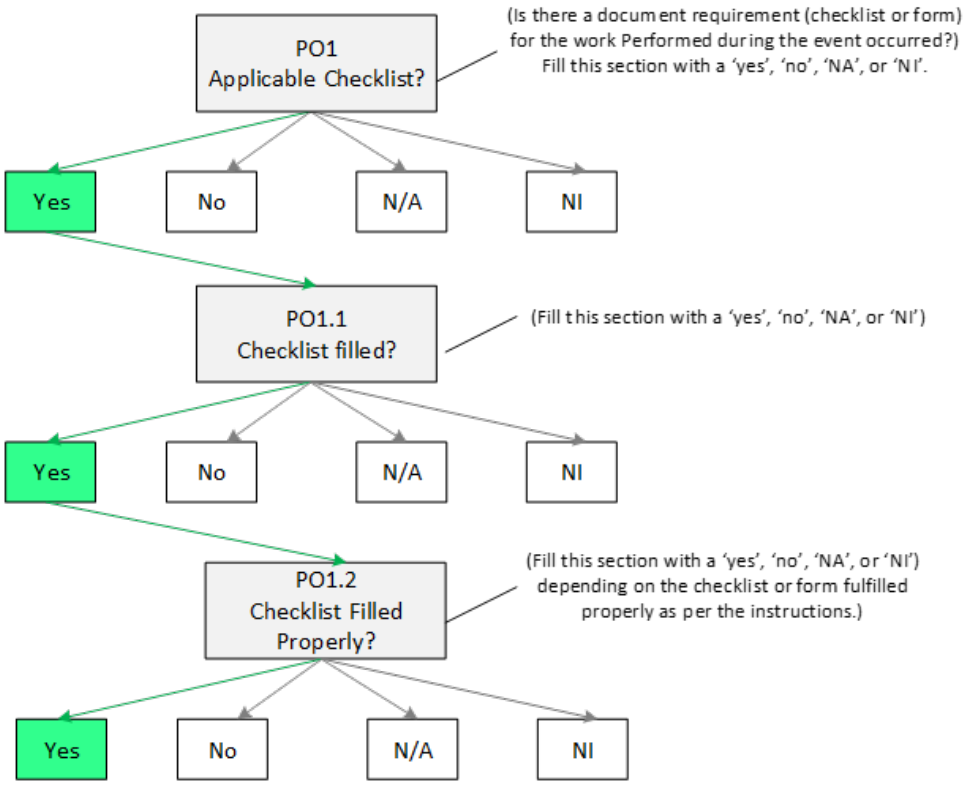

Figure 2. Methodology Applied for Extracting the Data related to Checklists

5.4. Correlation between Relevant Parameters in a Report

From data mentioned above 'Obtaining Statistical Data' title, 24 percent of the deaths were at night time and 76 percent were during the day time. In order to drive this sort of information and to find out the factors affecting the event, many questions are required to be asked and analyzed for relevance to see if the relationship is coincidental or actual.

Using the MEI Form data applied to 50 MOB event reports, the following statistical results were obtained: 36.7 percent of the casualties were alone and 63.3 percent of the casualties were not alone at the time of the MOB event. In the MEI Form, P03 under 'Managerial/Procedural Conditions', fatigue condition is specifically indicated. According to this, in 85 percent of the events, fatigue was not an issue.

5.5. Automating the Lessons Learned Process

Although the MEI Form does not directly cover a 'Lessons Learned' section, the relational topics to 'Lessons Learned' can easily be generalized and information extracted from the reports via categorizations. Designing a database architecture considering the categories of the lessons learned could improve the current Lessons Learned process of the IMO, shown in Figure 1. The use of the MEI Form and process described in this paper helps bring lessons learned from five studies that could be performed on the reports populated in the MEI Database (Figure 3).

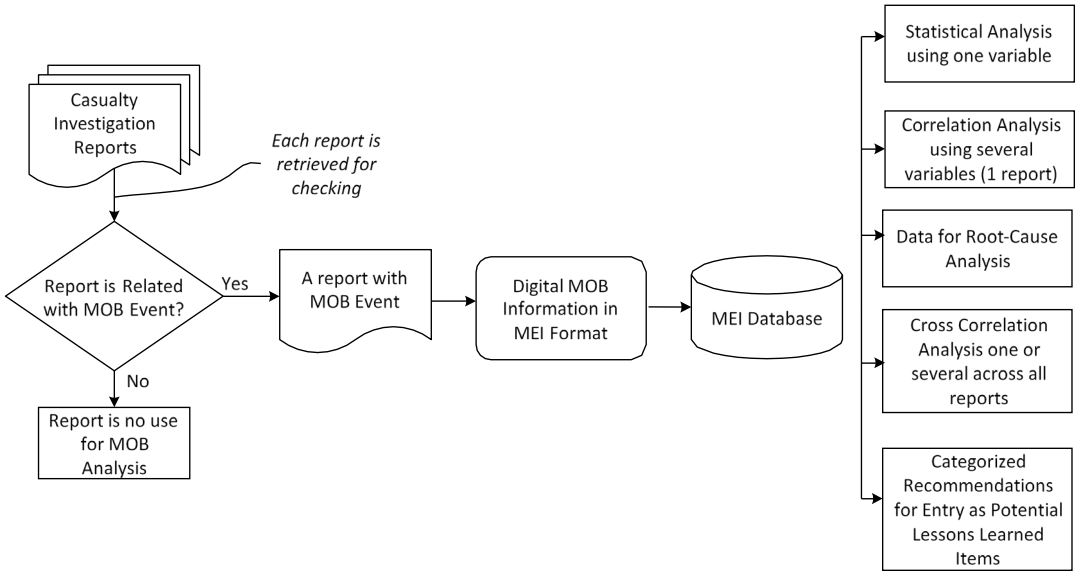

Figure 3. Methodology of MOB Reports Data Retrieval, Formatting, and Analysis Process.

6. CONCLUSIONS

More than 50 reports, involving MOB accident data, were reviewed. Reviewed reports indicated major differences in formats as well as in the level and type of information. A structured methodology was developed and presented for reviewing and retrieving the data systematically from MOB event reports. As part of this process, a standard form, called the MEI Form, is introduced. The MEI Form, with 113 information items, is presented with how to retrieve the information as a standard process. Several case examples are presented to demonstrate the standard use of the MEI Form including how to format, populate, and analyze the data.

Having the data investigated using the MEI Form showed a structured methodology for populating all MOB related maritime accidents digitally with a unique format. We propose the use this methodology to maritime investigating agencies in order to utilize the MEI Form. With this manner, structured data can be compared and consistently analyzed, which enables to drive measurable and usable "lessons learned" information and "recommendations". Data can be populated into the IMO websites for community use. Case examples also demonstrated how to perform the root cause analysis as well as how to retrieve the "lessons learned" items using the proposed methodology.

The use of the MEI Form for obtaining the statistical analysis results may be automated and the results may directly help areas to identify as for the improvements in, for example:

- MOB procedures
- Innovative technologies to utilize for detecting the event, preventing it from happening, or minimizing the risk level to the casualty before, during or after the MOB event respectively
- Analyzing one or several parameters for allowing lessons learned information gathered from analysis results

Casualty Investigation Code, which is adopted to set international standard for conducting the safety investigations and reporting is;

- Very generic
- Does not offer use of a specific method for analyzing root cause
- Does not guide key elements to be included

As a result of preparing these forms with the guidance of this generic code, serious inconsistences is observed in reports published by different agencies. To avoid these inconsistences, code must include;

- A specific approved method for analyzing root cause
- Minimum information required to drive root cause and lessons learnt.
- Format of investigation report
- Information required to acquire statistical data to analyze maritime accidents.

Benefits of using a common form when investigating maritime accidents and publishing these investigation reports are;

- Preparing a digital database instead
- Obtaining cross-check data between different factors
- Obtaining serious data to create simulations

If a digital database is prepared and enough data is collected, simulation scenarios may be established. As an example; a survivability simulation of a casualty that is immersed in cold water can be prepared if enough cross-check data is acquired. From such simulations very important data can be acquired to improve response methods. The data collection and data analysis are important issues for future research on MOB casualties. In future investigations, it might be possible to use big scale data sets. Therefore, a further study with more focus on big data analysis for MOB casualties is therefore suggested.

7. REFERENCES

URL-1, IMO-SOLAS regulation I/21. IMO Casualties Page, (2019). Accessed Date: 17/03/2019, http://www.imo.org/en/OurWork/MSAS/Casualties/Pages/Default.aspx.

URL-2, Maritime Pollution Act (MARPOL). IMO Casualties Page, (2019). Accessed Date: 17/03/2019, http://www.imo.org/en/OurWork/MSAS/Casualties/Pages/Default.aspx.

Contracting Governments, (1966). International Convention on Load Lines (LL Convention). Article 23, London.

United Nations, (1982). Convention on the Law of the Sea (UNCLOS). Article 94, Jamaica.

IMO MSC, (2008a). *IMO Maritime Safety Committee*, 84th session, pp. resolution MSC.255(84), revoking resolutions A.849(20) and A.884(21).

ILO, (2006). *International Labour Conference Maritime Labour Convention*, Regulation 5.1.6 – Marine casualties.

URL-3, IMO. Casualties. International Maritime Organization, (2019). Accessed Date: 12/03/2019, http://www.imo.org/en/OurWork/MSAS/Casualties/Pages/Default.aspx.

IMO MSC, (2008b). Code of International Standards and Recommended Practices for a Safety Investigation into a Marine Casualty or Marine Incident (Casualty Investigation Code), Resolution MSC.255 (84).

URL-4, IMO FSI Casualty Analysis Procedure (CAP), (2019). Accessed Date: 15/03/2019, http://www.imo.org/en/OurWork/MSAS/Casualties/Documents/CASUALTY%20ANALYSIS%20PROCEDURE.pdf.

Gano, D.L. (2007). *Comparison of common root cause analysis tools and methods. Apollo Root Cause Analysis-A new way of thinking*. Apollonian Publ.

Arslan, O., Güler, N., (2011). Kimyasal tanker işletmeciliği için stratejik yönetim modellemesi. *ITU Dergisi*, 10.

Kececi, T., Bayraktar, D., Arslan, O., (2015). A ship officer performance evaluation model using fuzzy-AHP. *Journal of Shipping and Ocean Engineering* 5: 26-43.

Akyuz, E., Celik, M., (2014a). Utilization of cognitive map in modelling human error in marine accident analysis and prevention. *Safety science* 70: 19-28.

Akyuz, E., Celik, M., (2014b). A hybrid decision-making approach to measure effectiveness of safety management system implementations on-board ships, *Safety Science* 68: 169-179.

Lim, C.H., (2010). A Study on the Introduction of IMO Casualty Investigation Code and Marine Safety Investigation System in Korea. *Journal of the Korean Society of Marine Environment & Safety* 16: 57-63.

Schröder-Hinrichs, J.U., Baldauf, M., Ghirxi, K.T., (2011). Accident investigation reporting deficiencies related to organizational factors in machinery space fires and explosions. *Accident Analysis & Prevention* 43: 1187-1196.

Moradi, A., Etebarian, A., Shirvani, A., Soltani, I., (2014). Development of a fuzzy model for Iranian marine casualties management. *Journal of Fuzzy Set Valued Analysis* 1: 1-17.

Fukuoka, K., Furusho, M., (2016). Relationship between latent conditions and the characteristics of holes in marine accidents based on the Swiss cheese model. *World Maritime University Journal of Maritime Affairs* 15: 267-292.

Weber, R., Aha, D.W., Muñoz-Ávila, H., Breslow, L. A., 2000. An intelligent lessons learned process. International Symposium on Methodologies for Intelligent Systems (ISMIS 2000), Vol. 1932, pp. 358-367, Berlin.

URL-5, IMO Global Integrated Shipping Information System, (2019), Accessed Date: 12/03/2019, https://gisis.imo.org/Public/MCI/Search.aspx.

URL-6, Our Work: Lessons learned English, (2019). Accessed Date: 12/03/2019, http://www.imo.org/en/OurWork/MSAS/Casualties/Pages/Lessons- learned.aspx.

URL-7, Our Work: Lessons Learned French, (2019). Accessed Date: 12/03/2019, http://www.imo.org/en/OurWork/MSAS/Casualties/Pages/Lessons- Learned-French.aspx.

URL-8, Our Work: Lessons Learned Spanish. International Maritime Organization, (2019). Accessed Date: 12/03/2019, http://www.imo.org/en/OurWork/MSAS/Casualties/Pages/Lessons- Learned-Spanish.aspx.

UK Inv., (2011). Fatal Man Overboard from Joanna. Alongside in Glasgow, Scotland, Rpt No 8/2011, 13 December 2010, *UK Marine Accident Investigation Branch*, June 2011.

Edmonston, C., (2012). Sobering MOB Facts, Boat Owners Association of the United States, *Boat US Magazine*. October-November 2012, pp. 62, Alexandria, USA.

APPENDIX A: Investigation Reports

Table A.1. Reports Selected for Reviewing their Contents as per the Requirements of RESOLUTION MSC.255(84).

#	Ship Name	Publishing Agency	Flag State	Report Name	Report Date
1	Forth Guardsman	MAIB Marine Accident Investigation Branch	UK	Fatal injuries to a crewman during mooring operations on FORTH GUARDSMAN South of Jura	September 2011
2	Hyundai Dangjin	Australian Transport Safety Bureau	Australia	Man overboard fatality from Hyundai Dangjin	19 January 2016
3	Federal Champlain	The Transportation Safety Board of Canada	Canada	Marine Transportation Safety Investigation Report M17C0292	06 September 2018
4	Kwong Fei 38	Marine Accident investigation Section	Hong Kong	Report of investigation into the fatal accident of a sailor fell overboard a local dumb lighter "Kwong Fei 38" and drowned in the waters east of Round Island on 13 January 2017	20 July 2018
5	Ribeye 785	Accident Investigation Board	Norway	REPORT ON MARINE ACCIDENT RIB, FALL OVER BOARD IN OLDEN 22 JULY 2015	March 2017
6	Skawlink III and Nord Gardenia	The Danish Maritime Accident Investigation Board	Denmark	2017SKAWLINK III and NORD GARDENIA Fall overboard on 29 September 2016	11 May 2017
7	MV MSC Ravenna	Marine Safety Investigation Unit	Malta	MV MSC RAVENNA Fatal fall overboard of a crew member in the port of M'Xlokk 22 June 2017	June 2018

APPENDIX B: Case Studies for Use of the MEI Form

This appendix show these of the MEI Form with three example reports as shown in Table B.1 to Table B.12. The report examples shown in Table B.1 to B.12 are the first three reports shown in Table A.1 in respective order.

Table B.1. Vessel Information

Code	Field Name	Report 1	Report 2	Report 3
V01	Event Number	1	2	3
V02	Vessel Name	Forth Guardsman	Hyundai Dangjin	Federal Champlain
V03	Flag	British	Liberia	Marshall Islands
V04	Vessel Type	Commercial (Other)	Cargo Ship	Cargo Ship
V04.1	Sub Category	Landing craft	NI	Bulk Carrier
V05	Age Group	21-30	0-3	NI
V05.1	Exact Age	28	3	NI
V06	Tonnage Group	500-999	50000+	NI
V06.1	Tonnage (GRT)	654	132587	NI
V07	Length Group	20-49	200+	NI
V07.1	Vessel Length	48.46	329.95	NI
V08	Vessel Classification	None	Nippon Kaiji Kyokai	NI
V09	Number of Personnel	6	NI	NI

Table B.2. Navigation Conditions

Code	Field Name	Report 1	Report 2	Report 3
N01	Navigation Status	No	No	No
N02	Operational State	In-Maneuver	Port	Port
N03	Was Duty Officer Alone?	No	NA	NA
N04	Who has the Command-in-Charge?	Ship's Captain	NA	NA
N05	Distance to Nearest Land	0	0	0
N06	Location	55°47.4'N 006°01.3W	20° 35.33' S 117° 10.50' E	Thunder Bay Terminals
N07	Ship's Draft (m)	NI	NI	8,08
N08	Ship's Speed (knots)	0	0	0

Table B.3. Casualty Status / Information

Code	Field Name	Report 1	Report 2	Report 3
C01	Rank	Deck Rating	Deck Officer	Deck Officer
C02	Nationality	Polish	NI	NI
C03	Age	47	NI	NI
C04	Overall Work Experience (On- board)	NI	NI	NI
C05	Work Duration (On-board Ship)	18 months	NI	NI
C06	Alcohol / Drug Influence	NI	NI	NI

Table B.4. Meteorological Conditions

Code	Field Name	Report 1	Report 2	Report 3
M01	Adverse Weather	Yes	Yes	Yes
M02.1	Wind Speed	6 (Beaufort)	3-4 (Beaufort)	0
M02.2	Wind Direction	NNE	NI	Calm
M03	Sea Scale	3.Nis	NI	0
M04.1	Sea Current Speed	NI	NI	NI
M04.2	Sea Current Direction	NI	NI	NI
M05	Rain	No	NI	No
M06	Visibility	NI	NI	6
M07	Sea Temperature	8	22	-2
M08	Air Temperature	NI	NI	-12,1
M09	Sea Depth	NI	NI	NI
M10	Darkness	Yes	NI	NI
M11	Lightning Conditions	Yes	NI	NI
M12	Day/Night	Night	NI	NI

Table B.5. Work Type and Conditions

Code	Field Name	Report 1	Report 2	Report 3
W01	Relevance to Work	Yes	Yes	Yes
W02	Working as per the safety rules	No	No	NI
W03	Workplace conditions as per the safety rules	No	Yes	NI
W04	Wearing a Life Jacket	No	Yes	No
W05	Alone	No	No	No

Table B.6. Managerial/Procedural Conditions

Code	Field Name	Report 1	Report 2	Report 3
P01	Applicable checklist	Yes	No	NI
P01.1	Checklist filled	Yes	NA	NA
P01.2	Checklist filled properly	No	NA	NA
P02	Applicable general work procedures	No	No	NI
P02.1	General work procedures implemented properly	NA	NA	NA
P03	Fatigue condition	NI	NI	NI
P04	Implementation of MOB drills	NI	NI	NI
P05	Was there a SAR Procedure?	NI	NI	NI
P05.1	SAR Procedure implemented appropriately?	NA	NA	NA

Table B.7. Start of the Event

Code	Field Name	Report 1	Report 2	Report 3
M01	Date	13.03.2011	10.07.2015	8.12.2017
M01.1	Time	1912	458	1950-2008
M02	Action causing the MOB event	Impact of rope	Reading Draft Marks	Reading Draft Marks
M03	From Where	Starboard Bow	Port	Port
M04	Immediate/Late Awareness	Yes	Yes	Yes
M05	Latency	NA	NA	NA
M06	Assumed Over Board	No	No	No
M06.1	Decision Duration	NA	NA	NA

Table B.8. Response Times and Actions

Code	Field Name	Report 1	Report 2	Report 3
T01	Event Notification to the Bridge	1-2	1	0
T02.1	Alarm	1-2	14	1-18
T02.2	Announcement	1-2	14-22	2-20
T02.3	Whistle	No	No	No
T03	Buoy	1-2	1	0
T04	Maneuvering	No	NA	NA
T05	Captain	0	2-4	0
T06	GPS MOB	NA	NA	NA
T07.1	Notification to Close by ships	2	No	No
T07.2	Notification to SAR Stations?	No	No	No
T07.3	Other Notifications	No	22-42	6-37
T08	Rescue Boat is Ready	4-9	No	6-24

Table B.9. Search and Rescue (SAR) Operation

Code	Field Name	Report 1	Report 2	Report 3
R01	Rescue Boat	No	No	Yes
R02	Timing of Rescue Boat In Water	NA	NA	6-24
R03	Other Ships	Yes	No	Yes
R04	Timing of Other Ships	11-20	NA	6-37
R05	SAR Ships	Yes	No	No
R06	Timing of SAR Boats	NI	NA	NA
R07	Air Operation	Evet	No	No
R08	Timing of Air Operation	49-72	NA	NA
R09	Shore Assistance	No	Yes	No
R10	Timing of Shore Assistance	NA	22	NA
R11	Casualty Removed from the Water	Yes	Yes	Yes
R12	Removed by	Ship's crew and other ship crew	Ship crew	Other ship crew
R13	Timing of Removal	11-20	14-22	8-37
R14	Cancellation of the SAR operation	NA	NA	NA
R15	Duration, Cancellation of the SAR operation	NA	NA	NA
R16	Limited Sighting of the Casualty in Water	No	No	NI
R17	Duration, Limited sighting of the casualty in the Water	NA	NA	NA
R18	Uninterrupted Sighting of the Casualty In Water	Yes	Yes	NI

Table B.10. Health Status of the Casualty

Code	Field Name	Report 1	Report 2	Report 3
H01	Death	Yes	Yes	No
H01.1	Witnessing death	Yes	Yes	NA
H01.2	Decision for death	No	No	NA
H01.3	Timing of Death	After	Later	NA
H02	Cause of Death	Trauma (chest)	NI	NA
H03	Duration until Death	120	67	NA
H04	Rescue to Death Timing	100-109	45-53	NA
H05	First Aid	Yes	Yes	NI
H05.1	Duration MOB to First Aid	1.Eyl	14-22	NA
H05.2	Duration Rescue to First Aid	Kas.20	1.Ağu	NA
H06	First Aid at or by the Medical Facility (Shore Side)	Yes	No	Yes
H06.1	Duration, time passed until First Aid given by at or by the Medical Facility (Shore Side)	72-120	NA	19-37

Table B.11. Type of Recommendation

Code	Field Name	Report 1	Report 2	Report 3
L01	Existence of Recommendation	No	No	No
L02	Number of Recommendation	0	0	0
L03	Recommendation Cat I	No	No	No
L03.1	Content of Rec Cat I	NA	NA	NA
L04	Recommendation Cat II	No	No	No
L04.1	Content of Rec Cat II	NA	NA	NA
L05	Recommendation Cat II	No	No	No
L05.1	Content of Rec Cat II	NA	NA	NA