Creation of an Occurrence Analysis & Learning Centre for Maritime (OALC-M). Results from EU Funded SAFEMODE Project

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ABSTRACT

The Occurrence Analysis & Learning Centre for Maritime (OALC-M) is a case study currently under development in the context of the European Union SAFEMODE project. The case study as part of the wider SAFEMODE project aims to promote contemporary safety thinking through a collection of carefully selected guidance and processes to investigators and safety managers within maritime organisations. The intent being, to encourage and help promote the adoption of the Safety-II construct across maritime organisations. Presently in the maritime industry, guidance on conducting investigations is chiefly focussed on a flag state level and is mandated through the IMO Casualty Investigation code and associated instruments. At an operator level (i.e., at a Shipping Company level) guidance on how to do this is scarce and it is left to the operator to decide on the investigation process, taxonomy used, analytical models & techniques, recommendations, and report format. The traditional, typical, approach adopted by the marine industry is reactive and based on a cause and effect, linear approach. OALC-M aims to utilise and encourage the adoption of SAFEMODE tools and techniques at an organisational level. This paper provides an initial description of the OALC-M case study and its scenarios targeted to shipping companies, which can benefit from the findings and tools created by the SAFEMODE project.

Keywords: *Human Factors; maritime safety; accident analysis, OALC-M; SAFEMODE*

1. INTRODUCTION

Within the available literature, it is possible to find numerous definitions regarding the concept of safety. For instance, ICAO (2013) defines safety for the aviation domain as “the state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management". In addition, this definition complies with the traditional idea of safety in the maritime domain as "a condition where nothing goes wrong or where the number of things that go wrong is acceptably small" (Patriarca, Di Gravio et al. 2017).

When conducting maritime accident investigations, the focus of the maritime industry and researchers has shifted over the last 50 years from design problems on the vessels to human error, with the ability to be expanded additionally into socio-economic factors. Hence, this provides room to multi-disciplinary research for future accidents considering not only the interaction between humans, the environment and technology but also the global conditions of the shipping market (Luo and Shin 2016). However, despite all the research that has been carried out in the past decades, there are still some difficulties when addressing Human Factors (HFs) into maritime accident investigations.

First, at a flag state level, guidance and structure for the completion of maritime accident investigations is already provided through international organizations such as the International Maritime Organization (IMO) or the European Maritime Safety Agency (EMSA). Nevertheless, at an operator level (e.g., Shipping Company, Port Authority, etc.) the guidance is less descriptive and not enforced following a clear structure. An example of the above is the International Safety Management (ISM) Code, which requires investigations into maritime accidents but is non-prescriptive in how the investigation should be conducted. Hence, different interpretations and applications of the ISM Code led to the creation of a wide variety of investigation types in varying degrees of quality, which lack the use of standard categories and taxonomies.

Second, in terms of safety, the traditional approach adopted by the marine industry had been focused on accidents, developing reactive regulations to prevent reoccurrence. Thus, maritime safety regulations have often been introduced as a response to an accident. For instance, after the loss of the Herald of Free Enterprise, the IMO adopted the International Management Code for the Safe Operation of Ships and for Pollution Prevention (ISM Code) and the Stockholm Agreement (1995) was the response to the sink of the vessel Estonia (Kristiansen 2013, Schröder-Hinrichs, Praetorius et al. 2015). The approach in the maritime industry is a one of reaction and predominantly, subconscious alignment to a Safety-I mindset, in which the level of safety is measured by the absence of accidents and incidents. The safety-I approach considers that causalities happen because something goes wrong and ensures that the causes can be found and treated (Patriarca, Di Gravio et al. 2017). Therefore, the focus on safety research has always been on unsafe behaviour rather than the safe operation. However, a higher percentage of the time the system is safe, so the additional useful information could be obtained by focusing on the positive events and by learning from them. Hence, within this new safety approach, the so-called Safety-II, the definition of safety shifts towards considering not only the adverse consequences but also the positive events, to succeed under varying conditions.

Finally, although there are plenty of available techniques to identify the contribution of HFs into maritime accidents, maritime organizations are neither aware of the fully catalogue of available techniques nor specialised in the use of the most suitable techniques to address a specific problem. This situation prevents maritime organizations from applying specific HFs techniques for accident investigation. In addition, the incorporation of HFs into safety analysis still results in a complex task (Jeong, Choi et al. 2016).

It is a fact that HFs are key to safety in the maritime domain, however, the problem lies first in the scarcity of data and available techniques to identify the contribution of HFs into maritime accidents at the design and safety assessment stages, when they can be most effective, and secondly in the lack of effective feedback loops from operations back to designers.

While the context and the background for this paper have been introduced above, the rest of this paper is structured as follows: Section 2 provides an initial overview of the SAFEMODE project and the Occurrence Analysis & Learning Centre for Maritime (OALC-M) case study. In addition, Section 3 includes a more detailed description of the scenarios that comprise the OALC-M case study. Finally, Section 4 provides a summary, conclusions, and the way ahead to ensure completion of the OALC-M case study.

2. THE SAFEMODE PROJECT AND THE OCCURRENCE ANALYSIS AND LEARNING CENTRE FOR MARITIME (OALC-M)

SAFEMODE is an H2020 Project that seeks to strengthen synergies between aviation and maritime in HFs, towards achieving more efficient and resilient mode of transportation. The main aim of SAFEMODE Project is to develop a novel Human Risk Informed Design (HURID) framework to identify, collect and assess HFs data to inform risk-based design of systems and operation related to the aviation and maritime sectors. Currently, both the maritime and aviation sectors not only lack a systematic approach to collect and assess HFs information, but also an agreed methodology to assess human-related risks. Figure 1 displays an overall view of the SAFEMODE project architecture.

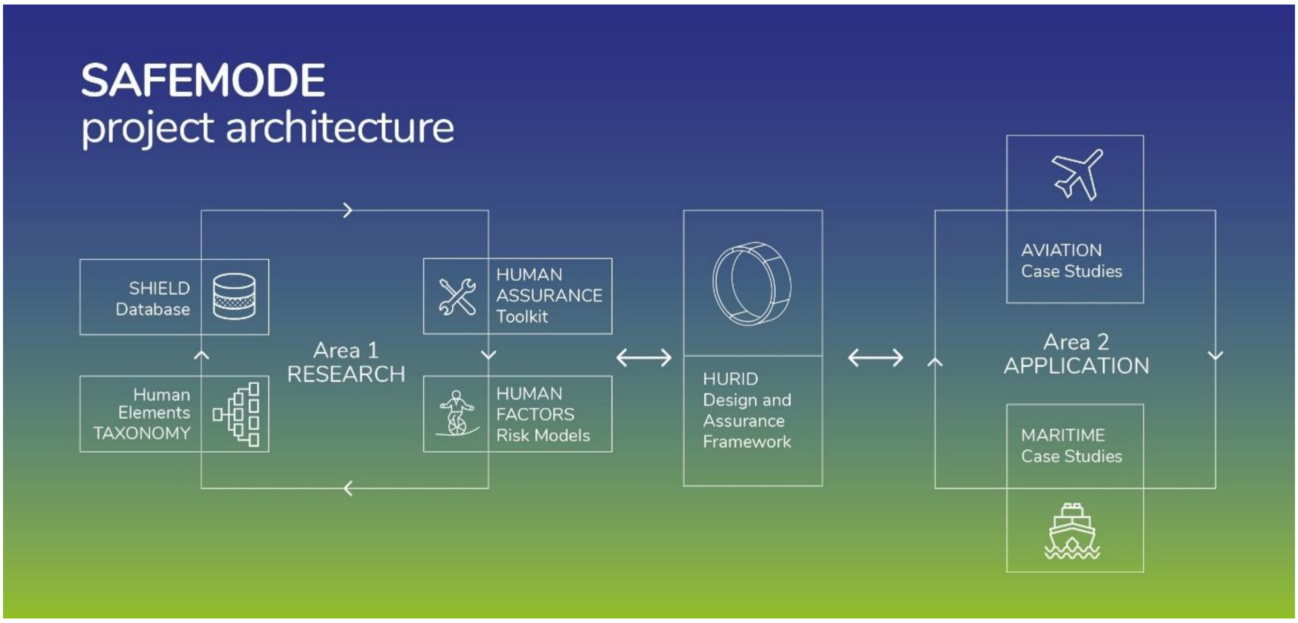

Figure 1 An overall view of the SAFEMODE project architecture.

Therefore, the research question that SAFEMODE addresses is “How to fully capture human elements, and their interaction with the other system elements, to enhance safety?”.

Consequently, to tackle the research question for the maritime domain, SAFEMODE is conducting various case studies, as part of the Area 2: Application (Figure 1), where the OALC-M case study is included. The aim of the OALC-M case study is to develop an enhanced accident investigation processes by utilising a HF centric approach, which will be oriented towards investigators and safety managers within maritime organisations. Thus, the core principles of this case study will be first, to seek to evolve existing investigation framework and guidance codes from international organisations, second, to create and encourage the adoption of an investigation process that is engineered and designed to be applied both reactively and proactively, and third, to provide end users with SAFEMODE harmonised tools for successfully collecting data during safe operations and near misses.

Therefore, the final goal of the OALC-M will be the creation of an investigation suite to project the SAFEMODE ethos and deliverables deep into the maritime domain, to positively influence and level-up the standards of marine investigation and proactive safety assessments. Hence. principles of SAFEMODE domain specific taxonomy (i.e., the SHIELD HF taxonomy), HFs, and Human Reliability Assessments (HRAs), and Risk Models amongst other elements will be at the heart of the OALC-M.

Moreover, the novelty of this case study is the relatively straightforward addition to the existing HFs and Risk based Investigation material for Maritime End Users. Hence, the two objectives seek from this case study could be summarised as follows:

- First, the creation and enforcement of a HFs and Risk-based Investigation Suite for maritime end-users, which can investigate adverse outcomes from accident investigations.
- Second, the development and enforcement of a framework that can investigate near misses and safe intervention to not only learn from accidents but also to learn lessons from safe practices.

In addition, the results from this case study and its successful implementation will provide a set of benefits as follows:

- Provide an enhanced investigation design that can also be used proactively to analyse successful outcomes and process optimisation.
- Support and accelerate the uptake and adoption of the SAFEMODE SHIELD HF taxonomy, enabling enhanced identification of performance influencing factors across multiple levels in an organisation.
- Support and accelerate the implementation of HRAs in maritime, aiming to assist end users to enhance the analysis and understanding of human contribution to maritime accidents.
- Support and accelerate the implementation of the SAFEMODE risk models, aiming to improve the assessment and management of future risks through the concept of barrier management.
- Enable the creation of intelligent, informed, and targeted interventions that focus on healing identified system weakness.
- Harmonised investigation backbone and output report facilitating cross functional (XFN) and cross organisational (XO) learning.

3. THE SCENARIOS OF THE OCCURRENCE ANALYSIS AND LEARNING CENTRE FOR MARITIME (OALC-M)

The OALC-M case study is composed by a higher-level concept or primary scenario, which consist of the development of a bi-directional HF and risk-based investigation process, and mainly three additional secondary scenarios, which will complement the higher-level concept.

The higher-level concept aims to develop a bi-directional HF and risk-based investigation process that harness the learnings and deliverables from the SAFEMODE Project that not only can be used reactively for accident investigation (i.e., to analyse incidents or accidents) but also proactively for safety assessment (i.e., to investigate near misses and safe interventions), as depicted in Figure 2.

In addition to the higher-level concept or primary main scenario, the OALC-M counts with three additional secondary scenarios, as described on Table 1.

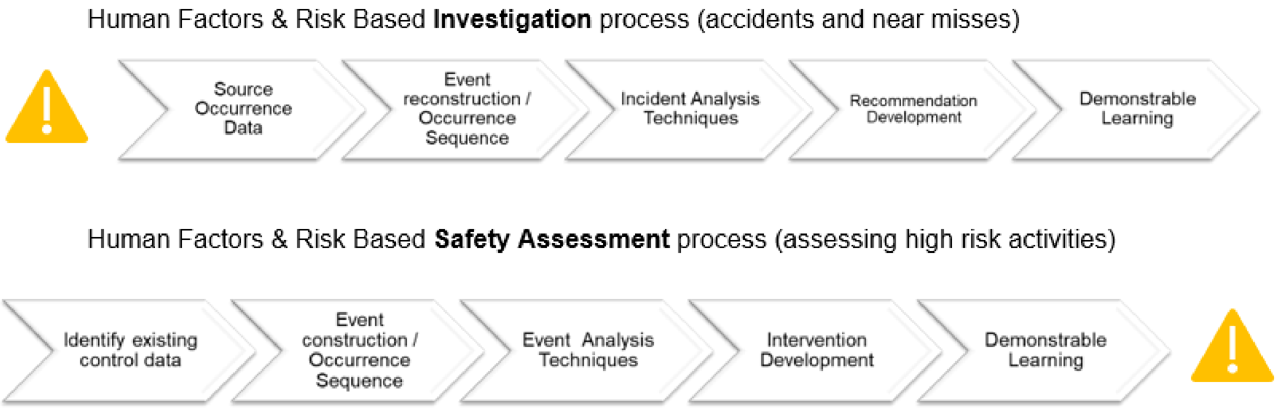

Figure 2 Higher-level concept or primary scenario of the OALC-M.

Table 1 Secondary scenarios of the OALC-M.

No.	Sub-scenario	Link with SAFEMODE Project
1	Utilisation and validation of SAFEMODE domain specific taxonomy	Supported by understanding the HF to be addressed via SHIELD HF taxonomy developed within the context of WP2.
2	Utilisation and validation of SAFEMODE HFs and HRAs	Supported by incident analysis techniques developed within the context of WP3.
3	Utilisation and validation of SAFEMODE risk models	Supported by the risk models developed within the context of WP4.

3.1 Scenario 1: Utilisation and Validation of SAFEMODE Domain Specific Taxonomy

This secondary scenario aims to enhance current procedures for data collection and its posterior utilisation in the maritime domain. In addition, specific tasks will be followed in the context of this scenario to complete the above-mentioned aim as follows:

- To develop HFs Interview Techniques and Question Set for Investigators.
- To describe the data available in SHIELD HF Taxonomy, and how the current data can be utilised at an operator level.
- To demonstrate the investigation workflow described in Figure 1 in a proactive mode (i.e., to develop a routine for process optimisation).
- To assist SAFEMODE project in the creation of a mechanism for users to submit proactive safety interventions that are recognised and raised before becoming a near miss.

3.1.1 Current Procedure for Collection and Utilization of Occurrence Data

To analyse an accident successfully, it is mandatory to ensure that the information regarding the sequence of events, and the HFs involved in the accident outcome are available and adequately collected. One of the most complete and comprehensive databases is the Accident/Incident Data Reporting (ADREP) system, which is maintained by the International Civil Aviation Organization (ICAO) and applied in the aviation sector. In addition, also the nuclear and chemical sectors have improved considerably when addressing HFs. Unfortunately, currently, there is not a harmonised procedure in the maritime sector for neither data collection of occurrence data nor HF information, as each organization follows a different procedure to collect the aforementioned information.

Moreover, there are numerous historical accident databases that are available within the maritime sector. For instance, the International Maritime Organization (IMO) accident database is one of the closest databases to be considered a standard classification system at an international level. In addition, there are accident databases, which record information at a national level (e.g., EU/EEA Member States utilise EMCIP).

3.1.2 The OALC-M Improved Procedure for Collection and Utilization of Occurrence Data

The improved procedure for collection and utilization of occurrence data that will be developed because of this scenario will seek the following objectives:

- First, the utilization of the SHIELD HF taxonomy for accident analysis, which was developed as part of the SAFEMODE project (SAFEMODE, 2020a).
- Second, the development of an HFs Interview Techniques and Question Set for Investigators that evolves from current procedures from international organizations (e.g., EMSA, IMO, etc.) and that can be linked back and identify contributing factors from SHIELD HF taxonomy.
- Third, the creation of a mechanism for users to submit proactive safety interventions that are recognised and raised before becoming a near miss.

3.1.3 Validation Criteria

In the case of a maritime accident investigation, the validation criteria can be achieved by benchmarking various techniques. For example, a current accident investigation report where additional techniques are utilised (e.g., TRIPOD, HFACS, etc.) could be re-analysed via the application of the SHIELD HF Taxonomy, which has been developed as a combination of HFACS and HERA techniques (SAFEMODE, 2020a). Therefore, the new SHIELD HF taxonomy will be validated considering the following criteria:

- Benchmarking. This will ensure that the use of SHIELD HF taxonomy not only will provide the same findings of previous techniques, but also that by using SHIELD HF taxonomy, additional benefits will be obtained. This will also encourage end users to move form their own accident investigation techniques and adopt the SHIELD HF Taxonomy.
- Feedback. The validation of the new SHIELD HF taxonomy will also be supported by feedback from SAFEMODE key partners, which will ensure that, a) the benchmarking exercise have been successfully conducted (i.e., the SHIELD HF Taxonomy have been correctly understood and applied), and b) the use of SHIELD HF Taxonomy provides additional benefits when compared with traditional methods.

3.2 Scenario 2: Utilisation and Validation of SAFEMODE HFs and HRAs

Currently, IMO only recommends applying the SHELL model and the GEMS framework for maritime accident investigation. However, this secondary scenario aims to implement the most relevant HFs and HRAs included in the SAFEMODE project (SAFEMODE, 2020b) to allow for the event reconstruction and the identification of the occurrence sequence during near misses and maritime accident investigations.

Within the context of this scenario, numerous HFs and HRAs will be reviewed to identify their applicability and to define potential areas of improvement, which can be achieved by implementing the HFs and HRAs developed through the SAFEMODE project. An overview of the main HFs and HRAs techniques included in SAFEMODE is displayed in Figure 3.

Therefore, specific tasks will be followed in the context of this scenario as follows:

- To apply HFs and HRAs to past accident investigation reports, aiming to make the approach understandable at an operator level.
- To create recommendations for the most suitable HFs and HRAs techniques, depending on the case under analysis.

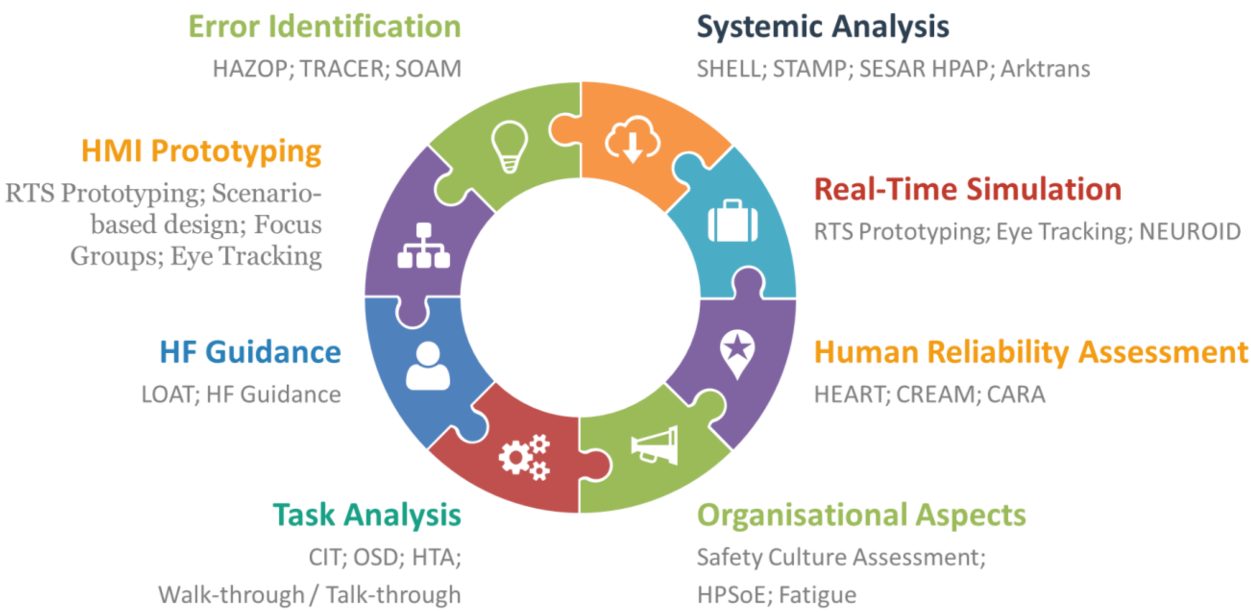

Figure 3 Samples of available HRAs to be used as part of the OALC-M.

3.2.1 Validation Criteria

In the context of this scenario, the validation criteria will also be achieved by benchmarking various HFs and HRAs techniques. As discussed above, this scenario will apply some HFs and HRAs techniques from the SAFEMODE project (SAFEMODE, 2020b) towards an analysis of a maritime accident. As an example, this scenario could apply various error identification Factsheets (Figure 1) from the library of HFs and HRAs techniques (e.g., HAZOP, SOAM, etc.) and validate them via benchmarking their results. Therefore, utilisation of SAFEMODE tools on a maritime accident will be validated considering the following elements:

- Benchmarking. This will ensure that the use of similar techniques will provide the same or similar findings. Thus, this will also encourage end users to use the HFs and HRAs included in SAFEMODE.
- Feedback. The validation activity will also be supported by feedback from SAFEMODE key partners, which will participate in this exercise to ensure that the benchmarking exercises have been successfully conducted, and the specific techniques that are applied in each example have been also validated via benchmarking.

3.3 Scenario 3: Utilisation and Validation of SAFEMODE Risk Models

The final secondary scenario that is being developed as part of the OALC-M case study will seek the following objective:

- The application of SAFEMODE risk model, which are included in the deliverable 4.1 (SAFEMODE, 2020c) and the deliverable 4.2 (SAFEMODE, 2021), to specific case studies, aiming to make the approach understandable at an operator level.

3.3.1 Validation Criteria

In this scenario, the validation criteria will also be achieved by benchmarking. An example could be the application of a risk model developed as part of SAFEMODE project (SAFEMODE, 2020c; SAFEMODE, 2021) into past maritime accidents, aiming to ensure and validate that the factors included in the risk model can reflect a wide range of scenarios, and they are not exclusive for a specific incident.

4. SUMMARY, CONCLUSIONS, AND THE WAY AHEAD

This paper has provided an initial description of the Occurrence Analysis & Learning Centre for Maritime (OALC-M) case study and its main scenarios, which is currently under development in the context of the European Union SAFEMODE project. Upon completion, this case study could be extraordinary valuable for maritime stakeholders, especially ship owners and shipping companies, since the novelty of this case study is the relatively straightforward addition to the existing HFs and Risk based Investigation material for Maritime End Users.

Furthermore, for the successful completion of the OALC-M case study, it is mandatory to ensure that the platform that will include all SAFEMODE tools, the taxonomy, and the downloadable materials (i.e., e-HURID platform) is fully functional. To ensure it, the OALC-M will seek the validation of the e-HURID platform, which will be achieved in two stages as follows:

- The first stage will include the validation of a mock-up version of e-HURID, which will be conducted before the platform is completed, aiming to identify shortcomings and additional features that need to be included in the platform. At this stage, the validation will be conducted by testing that, a) which specific material can be accessed, and b) which tools are already on place or planned to be included for the final version, that will allow to recommend end users specific techniques (e.g., a search function that allows to find specific tools, or a function that will allow to identify the best techniques for each end user based on their replies to specific questions).
- The second stage will include the validation of the final version of e-HURID, which will be conducted once the platform is completed and accessible to maritime end users. At this stage, the validation will be conducted by testing that some of the scenarios described in the OALC-M case study can be completed by using the e-HURID platform and the tools that are included there.

In addition, to guarantee the success of the OALC-M case study, it is also necessary to ensure that HURID is not only fully functional, but also that it can address specific end-users´ needs and requirements. To ensure it, the validation of HURID will be achieved as follows:

- Testing validation. Various scenarios will be tested via HURID to ensure not only the compatibility between the scenarios and HURID but also to demonstrate that HURID can solve end users' needs.
- Various sessions with SAFEMODE partners. These sessions will aim to guarantee that HURID can fully achieve and complete the needs from end users.
- Feedback. Findings will be circulated for feedback from SAFEMODE key partners.

5. ACKNOWLEDGMENTS

This publication is based on work performed in SAFEMODE which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814961. Any dissemination reflects the author's view only and the European Commission is not responsible for any use that may be made of information it contains.

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