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A new model of Port Safety Management: The analysis and risk management based on the Formal Safety Assessment (FSA):

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ARTICLE INFO ABSTRACT

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The present study aims to create a new model of port safety management in our country based on the analysis and assessment of the risk with the Formal Safety Assessment methodology to make it a first level instrument in the planning of the safety management of Port safety and also maritime port emergencies.

1. Introduction

This study aims to generate a new model management port safety in our country, based on risk treatment: risk analysis, risk assessment and risk management. Safety is always a risk option. The methodology applied is the Formal Safety Assessment, in relation to port risks, both in relation to maritime safety and marine security. The model also allows a better planning of response systems in the face of port emergencies.

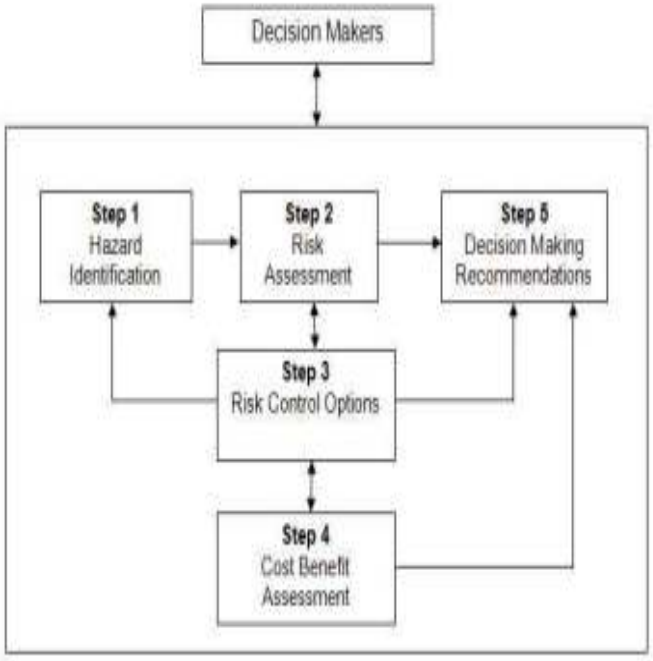
2. The Formal Safety Assessment

Originally developed in response to the *Piper Alpha* disaster in 1988 (an oil rig that exploded in the North Sea killing 167 people), from the Lord Carver Report, submitted to the British Parliament, the MCA proposed to the IMO a more scientific approach to the investigation of maritime accidents. It also began a proactive approach in the management of maritime safety, which since the Titanic in 1912 was in a reactive phase: after the incident a new regulation is generated. The right followed the fact.

Figure 1: Steps in the FSA process

The IMO describes the FSA (Formal Safety Assessment) as a structured and systematic methodology, with the aim of strengthening maritime safety, including the protection of human life, health, the marine environment and property, through the use of risk analysis and the evaluation of the cost of its benefits. In addition, the FSA is used as an instrument to evaluate the new regulations on maritime safety and the protection of the marine environment or in the comparison between existing rules and possible improved rules. All this with the aim of obtaining a balance between technical and operational issues, which include the human factor, maritime safety and the protection of the marine environment.
According to the IMO Guide (MSC Circular 1023): Risk is the combination of frequency with the severity of the consequence.

Risk Analysis is the systematic use of information available to identify hazards and estimate risk to people, property or the environment.



Source: IMO, MSC Circ. 1023

The FSA has been described by IMO as *"a rational and systematic process to assess the risks associated with maritime activity and to evaluate the costs and benefits of IMO options on reducing such risks"*.

The FSA emerges as a different instrument to fight against the production of marine accidents. It is not about correcting the causes of a particular disaster, which on the other hand is practically impossible to be repeated. But it is to avoid that these causes may be produced before the accident can happen. It also allows a rational and transparent evaluation in the process of creating new maritime safety rules and regulations, specifically including an assessment of the cost and/or potential benefits of the new regulations. The FSA takes express reason of the risks and its analysis in the management of the safety, also it takes advantage of the information derived from the accidents.

Risk Assessment is to review the risk acceptability that has been analysed and evaluated, based on the comparison with the standards or criteria that define risk tolerability.

Risk Management is the application of the evaluation with the intention of informing the decision-making process with the appropriate risk reduction measures and their possible implementation.

In the Anglo-Saxon literature the following expressions are used: HAZID (Hazard identification) for the study and identification of risks and hazards and HAZOP (Hazard operability), for the Operational Functional Analysis (OFA) this last technique is more focused on the operational aspects and the check of systems.

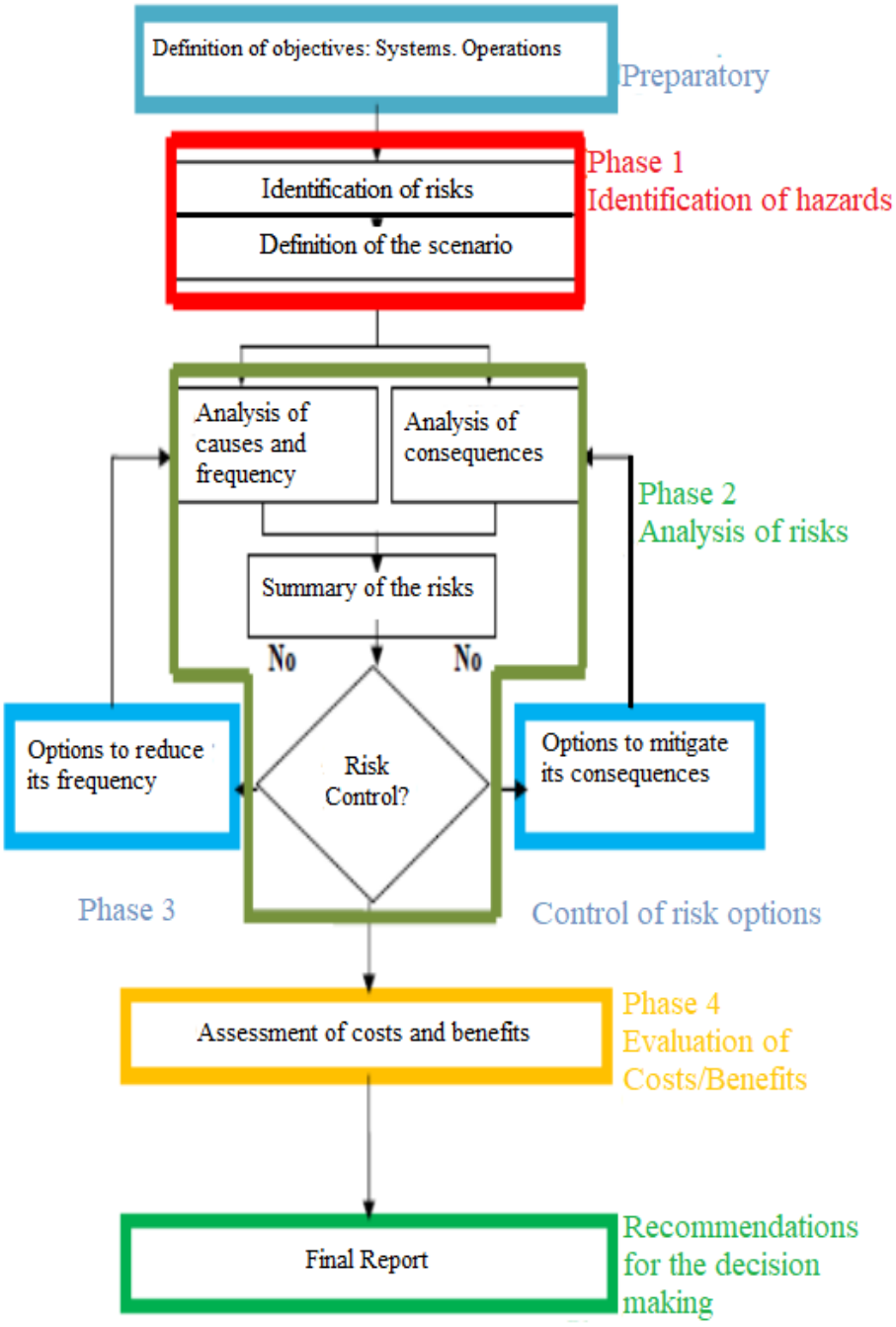
Table 1: Conceptual explanation of the FSA process

FORMAL SAFETY ASSESSMENT			*Current approach*
Phase 1	Identification of risks	What could go wrong?	What went wrong?
Phase 2	Analysis of risks, frequencies, possibilities and consequences	Which frequency? Which probability? Which magnitude?	
Phase 3	Identification of the options of control of the risk	How can things be done in a better way?	What should have been done to improve the situation?
Phase 4	Evaluation of the cost of the benefits	How much is it? How much is improved?	
Phase 5	Recommendations	Which actions are worth starting?	Which actions must be taken?

Source: JR de Larrucea 2015, on *"Maritime Safety"* p. 262 (Translation), (ISBN: 9788416171002)

The application of the FSA is divided into five phases. The following diagram shows the 5 phases of the FSA[2]:

Figure 2: Phases of the FSA process



[2] A full discussion of the process can be seen in the publication of the Kontovas K. Doctoral Thesis in *"Formal Safety Assessment: Critical Review and Future Role"*. Systematic work on the IMO Guidelines, Available from: (http://www.martrans.org/cvkontovas2.htm); Laboratory for Maritime Transport (2005); National Technical University of Athens.

Source: *Óp. Cit.* JR de Larrucea 2015, on “Maritime Safety” p. 261 (Translation) , (ISBN: 9788416171002)

The ALARP (**A**s **L**ow **A**s **R**easonably **P**racticable) Principle. For a risk to be considered ALARP it must be possible to demonstrate that the cost of continuing to reduce that risk is disproportionate compared to the benefit that would be obtained. That is, the risks should be avoided unless the difference between the cost and the benefit obtained is disproportionate. This equilibrium point has been incorporated into the FSA methodology, in its phase 4: cost-benefit assessment.

The FSA, in spite of its great formalism and being a complex process, enjoys great relevance and popularity, practically all maritime universities and research centres worldwide undertake or have undertaken /FSA studies. However, the FSA is not a "magic" instrument: it does not solve all the problems and does not answer all the questions. Within the MSC 79 the analogy with radar raised: it was thought that behind the radar the collisions would disappear. It should be borne in mind that when used correctly, it is a good instrument for comparing possible options[3], for a rational and transparent debate in the creation of standards and in the legislative debate and, of course, it provides a criterion of proportionality in safety management. An extremely interesting aspect is its influence on the design and construction of ships based on the identification of hazards and risks by vessel type (HAZID), an aspect that has revolutionized naval engineering[4].

[3] For example, thanks to the FSA, the IMO decided not to consider the need for a helicopter landing strip on passenger ships (SOLAS Chapter III, Article 28.1). In the same sense the proposal on the double hull for the bulkarriers. The FSA has been projected including air transport (SAM - *Safety Assessment Methodology* of EUROCONTROL). See of the author of this paper: *Maritime safety. General theory of risk* (2015); p. 259 et seq.

[4] Based on the work of SAFEDOR (http://www.safedor.org/), a research consortium created by the Shipyards and Classes within the framework of the 6th Framework Program of the EU. The essential reference work; see for all: Papanikolau A. in *Risk-Based Ship Design Methods, Tools and Applications*; Ed. Springer 2009.

3. Port Maritime Safety Management: the relationship between risk analysis and risk management

3.1. Background: The Port Marine Safety Code and the Safety Management System (SMS)

In the international area, the Port Marine Safety Code (PMSC) is a valuable precedent in its current version of 2016[5], based on the legal basis of the Pilotage Act 1987 modified in 1998 after the accident of the Sea Empress. The Code appears associated with a Guide of Good Practice for all members of the port community[6].

The *Port Maritime Safety Code* (PMSC) requires that all ports base their management of maritime operations (i.e. policies, plans and procedures) on a formal assessment of the dangers and risks for port navigation. In addition, port authorities must maintain a *Safety Management System* (SMS) developed from this risk assessment. It is important, therefore, that when certain maritime operations are carried out, such as special trailers, vessel movements or new operations, which are beyond the scope of the SMS, these operations are evaluated to determine the probable risk for the safety of navigation. Likewise, for each organization, the figure of the Designated Person who is considered the person who must ensure the objective adaptation between the SMS and the PMSC, perform audits, risk analysis, lessons learned, etc.

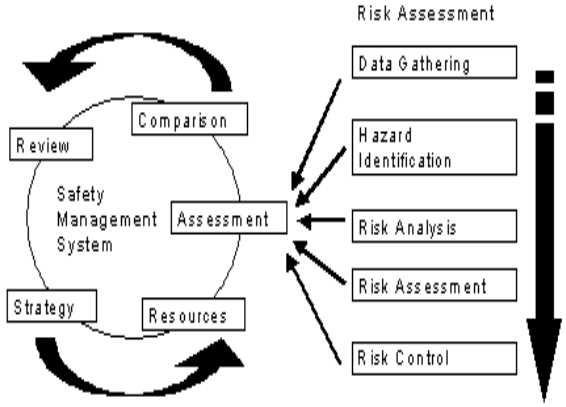
Also establish what additional or new risk control measures are required to reduce that risk to an acceptable level. The Harbour Master will advise the operators if any operation or trade belongs to that category. The result of this specific risk assessment can then be perfectly interconnected with the broader port SMS.

[5] Available from its current edition at: https://www.gov.uk/government/publications/port-marine-safety-code; from the HSE social work perspective see: http://www.hse.gov.uk/pubns/indg446.pdf

[6] Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/590160/guide-good-practice-marine-code.pdf

The relationship between risk analysis and risk management is explained by the fact that the risk analysis defines the risks, while the Safety Management System manages the risks. These are two phases that constitute different autonomous processes but that have an authentically symbiotic relationship; The two processes are only fully effective when used together.

Figure 3: Relationship between safety management system and risk assessment



Source: Port of London Authority PLA

3.1 The IHMA (International Harbour Master Association) and the figure and functions of the Harbourmaster in the management of maritime port safety

An extremely valuable reference from practice and professional experience is the position of the IHMA (International Harbour Master Association)[7] that highlights the role of the Harbour Master as a key figure in the development and implementation of a management system for the safety that manages the hazards and risks associated with port operations along with any emergency preparedness. This system must be operated efficiently and reviewed and evaluated periodically. The aforementioned association uses the FSA as a method of risk analysis not only in safety management, but also in emergencies.

The main function of the Harbour Master is the safety of all maritime operations. To achieve a safe harbour, you must consider what can go wrong and the best way to prevent it. This is the underlying principle of risk assessment, a practice that will not only lead to a safer port but will also help reduce insurance premiums, quality and costs and other commercial benefits for the port community. Good risk assessments can be used not only in the formulation of better operational procedures, but also in the formulation of effective emergency plans.

4. The identification of maritime risks (HAZID and HAZOP)

The main objective of the SAFEDOR European Research Consortium was the design of ships according to risk and their legal implementation schemes. SAFEDOR is an integrated project in the 6th Framework Program of the European Commission. The project started in February 2005 and ended in 2009. Under the coordination of the *Germanischer* Lloyd classification society, 53 companies (shipyards, consultants, etc.) and organizations (Class, Administrations, etc.) representing all parties involved in the European maritime industry. The Spanish partner of reference has been the NAVANTIA[8] shipyards. Initially it was decided to focus only on the four most representative and most economically significant types of ships for Europe: cruise ships, RoRo/RoPax, gas carriers and container ships. Later oil tankers were also included.

Risk is used as an objective instrument to evaluate the effectiveness of design changes with respect to safety. The main idea in the SAFEDOR project was the Design for Safety concept, which describes the integration of safety as an objective in the design process to minimize risk, along with traditional design objectives such as minimizing energy requirements and maximize the load capacity.

5. Identification of Port Risks ((HAZID and HAZOP)

[7] See: http://www.harbourmaster.org/hm-port-safety.php

[8] See the official website Available from: www.safedor.org

Two bibliographical references appear as essential in the material on the analysis and treatment of port risks and more particularly in the HAZID of these risks: *Navigational Risk Assessment - Guidance to Operators and Owners of the PLA*[9] *and the Port & Harbour Risk Assessment* and the Guide *Safety Management Systems in New Zealand*[10].

Examples of Hazard Titles identified in the PLA's navigational Safety Management System of London:

Contact - Class V Passenger Vessel with Bridges
Collision - Private Leisure Craft (River)
Collision - Tanker Berthing (Sea Reach
Collision - Large Tanker (River)
Contact - Vessel in Southend Anchorage
Contact - Tanker at Coryton/Canvey
Collision - VLCC (Black Deep and Knock John)
Contact - Thames Barrier (Barrier Open)
Contact - Tanker alongside Vopak
Fire/Explosion - Any Jetty
Wash - Passing Traffic
Contact - Vessel anchored in Gravesend Reach
Contact - Tanker alongside ST Services
Fire/Explosion - Fire on Class V Passenger Vessel
Collision - Vessel leaving Sea Reach Anchorages
Chemical Tanker (River)
Contact - Passenger jetty, pier or pontoon.
Contact - Bridge (Tower to Richmond)
Contact - Vessel in Leigh/Yantlet Anchorage
Collision - Knob Buoy
Grounding - Pilot/PEC/Master's Error
Contact - Small Bulk Carrier & Bridge
Collision - Bugsby's/Blackwall Reach
Grounding - Princes Channel (Western End)
Contact - Vessel on Erith Tier/Swing Buoy
Contact - Jetties, Berths, during river passage
Collision - Bunker Barge
Collision - Chemical Tanker (Estuary)
Collision - Small Bulker and Tug/Tow
Collision - Small Bulker Class V Passenger Vessel
Collision - Erith Rands/Erith Reach
Grounding - Warp/Oaze Area
Grounding - Across Dredged Box
Contact - Greenhithe Swing Buoy/Vessel moored nearby
Collision - Long Reach
Collision - Yantlet Channel
Contact - Inside Berths
Collision - E. Swin Channel (Nr Whitaker Buoy)
Contact - Moorings or vessel on Moorings
Mooring Breakout - (Tanker)
Grounding - Knock John Channel
Grounding - London Bridge to Teddington
Contact - Groynes off Diver Shoal
Contact - Tanker alongside Esso Purfleet
Contact - QEII Bridge
Contact - Propulsion system immobilized
Collision - Passenger Ship (River)
Collision - Product Tanker (River)
Contact - Oikos (Heavy Landing)
Contact - Coryton No 4 Upper Dolphin (Berthing)Collision - Oaze Deep
Collision – West Oaze - SR1
Loss of Hull Integrity - Sinking of Small Vessel
Collision - Lower/Upper Pool
Collision - Dredger
Collision - Gravesend Reach
Grounding - Yantlet Flat, Grain Spit, Nore Sand
Grounding - Vessel with incorrectly reported draft
Collision - London Bridge to Bell Lane Creek
Collision - St. Clement's Reach

6. Conclusions:

1st) The vision of safety must be developed at the higher level of port management and not as a secondary or collateral aspect. Risk management plays a fundamental role in the safety and protection of the institution, and therefore becomes a mission.

2nd) Knowledge of risk management reduces risk and helps the development of ports and increases their productivity. Training for risk management is the process of practicing the necessary skills to develop

[9] See: https://www.pla.co.uk/Safety/Navigational-Risk-Assessment-Guidance-to-Operators-and-Owners
[10] See: https://www.maritimenz.govt.nz/commercial/ports-and-harbours/documents/Port-harbour-risk-assessment.pdf

a risk assessment and port safety management, and it has become an integral part of the port strategy.

3rd) The ports should study and plan properly HAZID and HAZOP and effectively apply risk management to all types of risks. The maritime HAZID can be estimated from the existing studies (i.e. SAFEDOR UE), however there is a lack of SAI studies per port of the local HAZIDs and the particular port risks. The experiences and models of other countries can be of great help.

4th) *Lege ferenda* would be desirable to have a Port Maritime Safety Code which suppose that all ports base their management of maritime operations (i.e. policies, plans and procedures) on a formal assessment of the dangers and risks to navigation in port.

5th) Whether or not a code is available, port authorities must maintain a *safety management system* developed based on this risk assessment.

6th) The risk management system must be implemented for all Spanish ports in agreement with the FSA. After the determination and analysis of risks, emergency plans must be consistent with them and with the risks planned and studied. The only approach to risk in our port system is in relation to the ISPS protection (RD 1617/2007), however he SECUREPORT model of vulnerability and risk assessment in relation to protection has methodological dysfunctions.

7th) The Spanish model of port safety is characterized by the dispersion of powers and administration and a succession of different plans and sub plans, without unitary criteria: PPP, PPIP, PAU, PEI, PIM, IPP, etc.; with different managers and protocols, a critical aspect that reduces effectiveness in the treatment of crisis and emergencies. For illustrative purposes: the deliberate burning of a ship in port would activate the *Port Protection Plan* (illicit act); In relation to the fire, the SPP/IEP: *Self-protection Plan* or *internal emergencies* and in relation to the contamination of the IMP (Interior Maritime Plan) or the IMP of the port facility.

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