SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2022
ORGANIZATION AND MANAGEMENT SERIES NO. 157

RISK MANAGEMENT AS A SHIPPING COMPANIES TOOL FOR SAFE MANAGEMENT OF SEA-GOING VESSELS

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Purpose: reasons for writing the paper is to present, the optimal procedure to manage of risk and Risk Assessment procedures in shipping companies and on-board sea going vessels.
Design/methodology/approach: an analysis of various shipping companies approaches to management of risk and requirements and methodology to perform Risk Assessment.
Findings: found that approach to Risk Management and requirements to perform Risk Assessment are varied between shipping companies.
Research limitations/implications: management of risk based on Risk Assessment to be simplify and unified.
Practical implications: suggestion is given to unify procedures for Risk Assessment.
Social implications: reduction of risk to happen undesired events and mitigations of hazards associated with day to day operation of sea-going vessels.
Originality/value: recommendation to shipping companies for modification of Risk Assessments procedures where is necessary to improve safety on board.

Keywords: Risk Management, Risk Assessment, Safety Management System.

Category of the paper: research and viewpoint paper.

1. Introduction

Maritime transport accidents are complex and caused by a combination of events or processes that might ultimately result in the loss of human and marine life, and irreversible ecological, environmental and economic damage (Balmat et al., 2009; BS, 2008; Goerland and Montewka, 2015; Puisa et al., 2021). Many studies point to direct or indirect human error as a major cause of maritime accidents, which raises many unanswered questions about the best way to prevent catastrophic human error in maritime contexts. Maritime transport accidents are complex and caused by a combination of events or processes involving various actors that ultimately lead to disastrous consequences including loss of human and marine life and

irreparable ecological, environmental and economic damage (Dominguez-Pery et al., 2021). Apart from uncontrollable acts of God defined as ‘an extreme interruption with a natural cause (e.g. earthquake, storm, etc.), the literature consistently highlights human error as one of the main contributing factors in more than 85% of cases of maritime accidents. Furthermore, experts estimate that 30-50% of oil spills are caused directly or indirectly by human error (Dominguez-Pery et al., 2021; Haugen et al., 2016; Puisa et al., 2021). This paper takes one of first steps towards addressing some of these questions by improving our understanding of upstream maritime accidents from an organization science perspective—an area of research that is currently underdeveloped. The global shipping industry is responsible for transporting as much as 90% of world trade (Puisa et al., 2021). Over the past decade, improved ship design, technology, regulation and risk management systems have contributed to a 70% drop in reported shipping losses (Goerland and Montewka, 2015). However, while the frequency of maritime accidents may be in decline, one single incident can have catastrophic and long-term consequences for marine ecosystems, the environment and local economies. The operation of a ship, including the operation of a ship's engine room, is associated with risk-taking, just like any other human activity, in the case of routine operations related to the operation: cargo operations, manoeuvres and sea passage, emergency situations, repairs and maintenance works. Examples of some of the common risks that lead to these consequences include ship collision and grounding (Goerland and Montewka, 2015), fire (Goerland and Montewka, 2015), flooding (Zhang et al., 2019) have been analyzed.

Risk can be defined as undesirable events or as the probability of an unfavorable hazardous situation or an accident occurring. Thus, a risk is a combination of the probability or frequency of occurrence of a defined hazardous situation and the multiplicity of consequences resulting from its occurrence-BS 4778 (BS, 2012). Engineering Council, 1993 Guidelines on Risk Issues defines risk as a measure of the probability of the occurrence of a specific undesirable event and the resulting unwanted consequences or resulting loss. Risk Management based on its assessment is based on a detailed analysis of activities that involve risks and used to reduce the risk of activities or supportive measures. The Risk Assessment is an integral component of the SMS- Safety Management System based on the ISM Code and OHSAS 18001: 2007 (BS, 2007; Josi, 2021), the purpose of which is to protect against the identified threats, the risk level of which has been defined. The purpose of the Risk Analysis is to make sure that a detailed analysis of activities and procedures related to the operation of the ship is carried out in order to identify possible hazards that may cause a hazardous situation and that the existing preventive actions are sufficient and adequate to prevent potential hazardous situations from occurring (Balmat et al., 2009; Haugen et al., 2016; Montewka et al., 2014). On Figure 1 model of Risk Management has been presented.

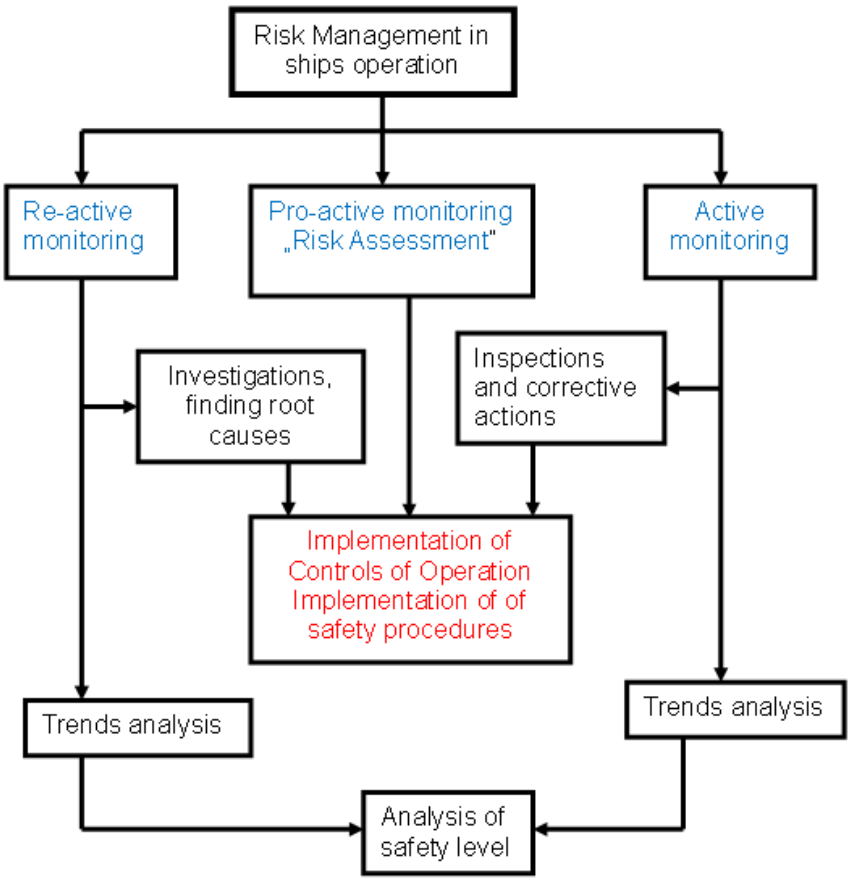

Figure 1. Model of Risk Management.

Effective Risk Management requires proper Risk Assessment procedures. The first step in creating an effective risk-management system is to understand the qualitative distinctions among the types of risks that organizations face (Culp, 2020). Our field research shows that risks fall into one of three categories. Risk events from any category can be fatal to a company's strategy and even to its survival. The Risk Management method which consists of identification of threats and introducing safeguards after an accident, can be called a "reactive method" of safety control and supervision (BS, 2012; Tchankowa, 2002; IMO, 1998; 1999). This method is strengthened by active monitoring (in the form of inspections) to confirm whether the introduced security measures are applied. Such inspections generate reports: NCR (Non- Conformity Reports), TLC (Total Lost Control), CAR (Corrective Action Request). Active and reactive monitoring of operational safety on board is required by the ISM Code and this is reflected in accident reports or "Near Miss" reports reported by ship crews. **Risk Assessment is an element of pro-active Risk Management** (CA, 2000; Kaplan and Mikes, 2012; Puisa et al., 2021). Risk managers need to do more than identify and mitigate potential risks. They can, for example, tap into external data sources to identify digital signals that provide early indicators of potential future problems. The shipping company is obliged to introduce an effective risk management system and is obliged to use active, re-active and pro-active systems (IMO, 1998; 1999; BS, 2007).

There are three main risk areas in the operation of a sea-going ships:

- Risk related to the ship's crew (related to health and safety at work), the consequences of which are accidents at work or, in drastic cases, deaths.
- Risk related to the property (ship operation), the consequences of which are failures of machinery and equipment ship, destruction or loss of cargo, loss of charter, sinking of a ship, etc.
- Risk related to the environment, the consequences of which are environmental pollution (water, air, land).

The Risk Analysis is designed to answer simple questions:

- What could go wrong? What hazards could lead to an accident.
- What is the probability that something bad could happen.
- What will happen if the potential danger becomes real, what will be the consequences.
- What category are these consequences?
- What can we do if we know the consequences can be significant? Eliminate some of the potential dangers, reduce or limit the effects of the potential threat.

2. Identification of activities related to the operation of the ship

Before carrying out the risk analysis, it is very important to make an inventory of activities related to the operation of the ship related to hazardous situations that may endanger people, the environment and private property or damage the reputation of the shipping company. An organizational structure exists on ships for a long time, so the categorization of the operational situation is facilitated. Figure 2 shows a diagram to illustrate the identification of risky activities related to the operation of a ship (LRS, 2006; Mikulski, 2015; Danney, 2017; Finnley 2018; Smith, 2020).

A good starting point for hazard identification is to check if there is any history or if there is an accident trend in the area of a given operational activity.

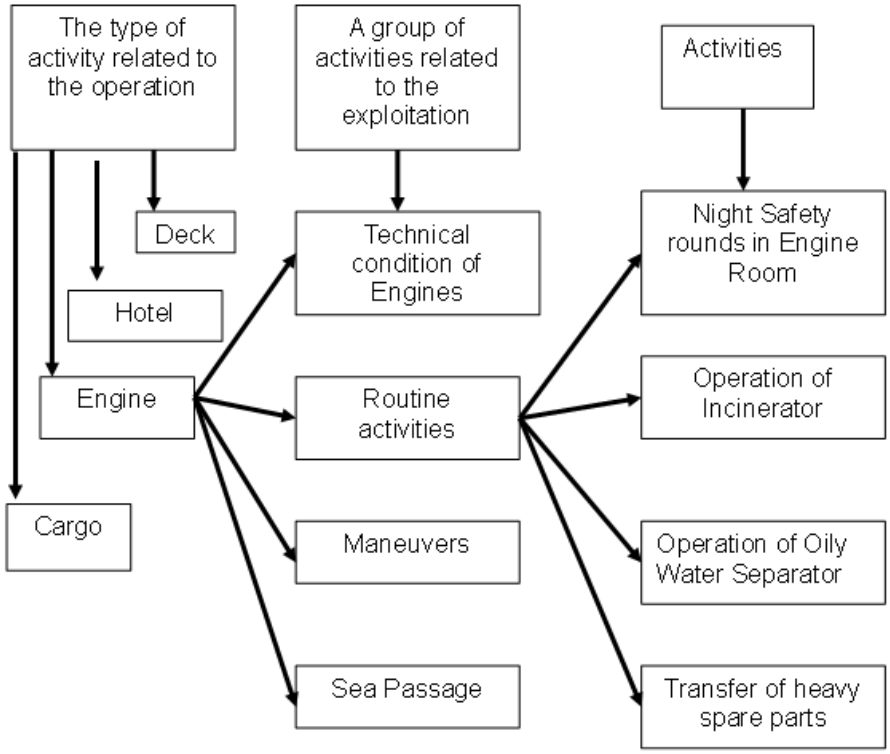

Figure 2. Example of identifying risky activities related to ship operation.

3. Hazard identification and identification of the existing control systems

Hazard in the sense of Risk Assessment can be defined as a source or situation that may cause harmful effects such as injuries or damage to the human body, damage or destruction of cargo, environmental pollution or combinations of the above-mentioned effects.

Example:

HAZARDS	CONSEQUENCES
Slippery surface	Injury of leg
Explosive atmosphere	Death-causing explosion
Toxic atmosphere	Death-causing poisoning
Darkness	Head impact with minor injury.

When identifying hazards, we should ask ourselves three questions:

- Is there any source of the hazard?
- Who or what might be at risk?
- How could this hazard occur?

Sources of hazardous situations can be distinguished as following (BS, 2007; Josi,2021):

- Materials and products used.
- Work procedures.
- Equipment/tools used.
- Personnel.
- Work site.
- Environment.

Hazards can be selected by type as follow (LRS, 2006; Mikulski, 2015; Danney, 2017; Finnley, 2018):

- Physical: noise, vibration, radioactivity, temperature, pressure, velocity, altitude, electricity, physical characteristics/properties.
- Chemical: explosives, combustible materials, corrosive agents, oxidizing agents, toxic and carcinogenic agents, gases and dust in the air.
- Ergonomic:
  - ✓ Physical: poor qualifications, unfamiliarity with routine procedures, duration of work and monotony, design deficiencies, poor posture (bad body position) incorrect lifting and lifting methods.
  - ✓ Environmental: poor lighting, poor ventilation, no possibility to control the environmental temperature, improper air humidity.
- Biological: biological waste (blood, fluids, etc.), drugs (antibiotics, marijuana), viruses and bacterias, parasites and insects, poisonous food, animals, improperly prepared food, poisoned/contaminated water.

Before determining the harmful effects of potential hazards in the event of their occurrence (the effects of potential hazards), the existing control systems should be analysed in terms of their effectiveness in reducing or eliminating hazards.

Hazard control systems can be divided into the following categories:

- Procedural.
- Environmental.
- Human relation.
- Personal protective equipment.
- Design and technical operation.

Practically, the purpose of risk analysis is to conduct appropriate preventive actions to protect against the occurrence of dangerous situations for people, the environment and private property. As shown on Figure 3 management of risk using legal regulations and work procedures cannot lower risk to acceptable Low Risk. To lower Risk to acceptable level it is necessary to use additional controls through proper Risk Assessment.

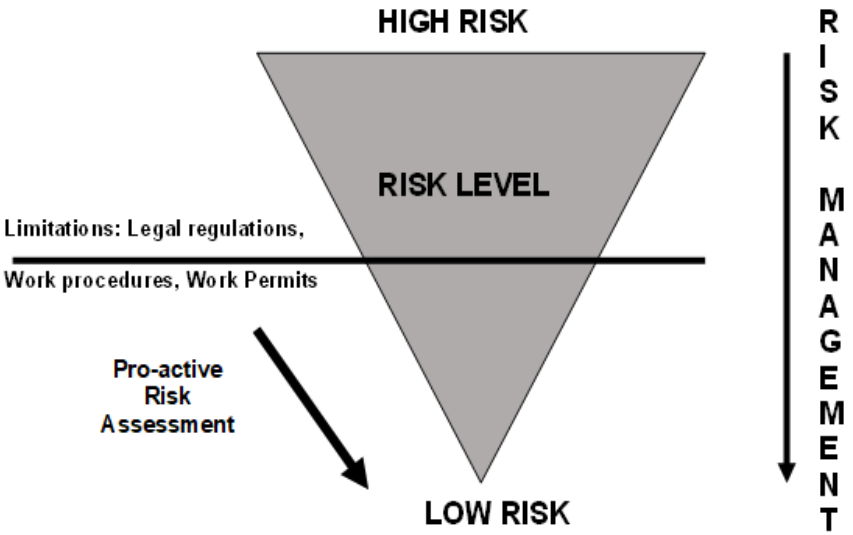

Figure 3. Possibility of Risk Management.

The risk analysis should be carried out in six stages (MCA, 2000; Montewka et al.,2014, Puisa et al., 2021; BS, 2007):

- Detailed analysis of activities and procedures related to the operation of the ship.
- Identification of possible hazards that may result in an accident.
- Assessment of the likelihood of an accident and the consequences of dangerous incidents or accidents.
- Determining whether the existing preventive measures are sufficient and adequate.
- Determining the level of risk.
- Reviewing the risk assessment performed.

4. Risk Determination

Risk Determination is a combination of:

- The likelihood that a hazardous situation will occur.
- The breadth of the consequences.

The risk can be assessed using two methods:

- **Qualitative Risk Assessment**, when we have very little or no statistical data on a given hazard, the method is cheap and fast, used in the case of personal safety risk assessment (Embrechts et al., 2005; Karaseva, 2020).
- **Quantitative Risk Assessment,** when we have statistical data on risk frequency and consequences, expensive and time-consuming method (Embrechts et al., 2005; Karaseva, 2020).

The Risk Assessments performed on board ships is based on the Code of Safe Working Practices for Merchant Seamen (BS, 2012) is a qualitative method applied to the hazards associated with the work carried out by crew members on board ships. Therefore, in shipping companies, a Risk Assessments are carry out in terms of threats related to the work carried out by crew members and environmental hazards (Mikulski, 2015; Danney, 2017; Finnley, 2018; Smith, 2020; Josi, 2021).

Assessment of the likelihood and consequences of a hazardous situation is burdened with the subjectivity of the person conducting the assessment, because there is no data, but in the future, when data banks are created, the assessment process will be much easier. The table 1 presented below is a recommended template for determining the probability.

Table 1.
Recommended table for determining the probability of a hazardous situation (BS, 2007).

Unlikely	Very low possibility of occurrence but it may occur in exceptional circumstances. It could happen but probably never will. Less than 5 % chance of occurrence. Less Than 1% chance of being experienced by individuals within their work life time.
Possible	Not expected to occur in normal circumstances but there is a slight possibility it may occur at some time. Less than 25 % chance of occurrence. Typically experienced once during the working lifetime of an individual.
Quite Possible	Could occur at some time. There is a history of casual occurrence. 25% to 50 % chance of occurring. Typically experienced once in five years by an individual.
Likely	Will probably occur in most circumstances. 50% to 75% chances of occurrence. Typically experienced once every six months by an individual.
Very Likely	Can be expected to occur in most circumstances. More than 75% chances of occurrence.

In table below (Table 2) authors present recommendations for quantifying the consequences of making a potential threat real. It is recommended to use practically in assessing the risk on board ships (BS, 2007).

Table 2.
Recommendations for quantifying the consequences of making a potential threat real

Negligible	Minor First aid Injury – cut/wound/bruise/sprain Inability to sail up to 1 hour Inconsequential impact on environment – contained in save-alls Financial loss < $5000. Superficial damage No effect on Commercial venture.
Slight	Medical Treatment Injury Inability to sail for more than 1 hour but less than 3 hours Less than 1 barrel of oil spilled on deck Financial Loss > $5000 but < $100,000. Minimum damage Minor effect on commercial venture, minor local public reaction.
Moderate	Restricted Work Case Injury Inability to sail for more than 3 hours but less than 12 hours More than 1 barrel oil spilled on deck Financial loss > $100,000 but < $1000,000. Minor Damage Some local public reaction. Minor National media coverage.

Cont. table 2

High	Lost Workday Injury Inability to sail for over 12 hours but less than 24 hours Less than 1 barrel of oil spilled into the water Financial loss > $1 million but < $10 million. Damage that temporarily threatens Safety and the Environment Threat to future commercial business. Major media coverage.
Very High	Fatality, Serious Body injury Inability to sail for over 24 hours More than 1 barrel of oil spilled into the water Financial Loss > $10 million. Damage that seriously threatens Safety and Environment Severe pressure on commercial business. Major National and International media coverage, public outcry.

When the probability of a hazardous situation has been assessed and the consequences that may occur when a hazardous situation occurs, then assess the risk can be done using the recommended presented below table (Table 3).

Table 3.
Risk ranking matrix (BS, 2007; Josi, 2021)

RISK MATRIX		**Likelihood**				
		1: Unlikely	**2: Possible**	**3: Quite Possible**	**4: Likely**	**5: Very Likely**
Consequence	**1: Negligible**	Low Risk	Low Risk	Low Risk	Medium Risk	Medium Risk
	2: Slight	Low Risk	Low Risk	Medium Risk	Medium Risk	Medium Risk
	3: Moderate	Low Risk	Medium Risk	Medium Risk	Medium Risk	High Risk
	4: High	Medium Risk	Medium Risk	Medium Risk	High Risk	High Risk
	5: Very High	Medium Risk	Medium Risk	High Risk	High Risk	High Risk

Assessed according to Table 3, risk is combined with the recommended management practices to bring the risk down to the level of tolerable risk. The recommended actions are presented in Table 4. Where the risk is at an unacceptable level, additional preventive measures should be put in place to reduce the risk to an ALARP (as low as reasonable practicable) level, as low as reason and practice allow (Embrechts et al.,2005; Kaplan and Mikes, 2012; LRS, 2006; BS, 2007). This applies to any work related to the operation of the ship, repair and maintenance works, cargo operations.

The idea of ALARP allows for the analysis of costs related to increasing the level of safety and determines possible financial outlays to achieve a satisfactory level of safety ensuring a reduction in accident rates.

Table 4.
Recommended actions depending on the risk level (LRS, 2006; BS, 2007).

Risk category	Measures	Work authorization
High Risk (Unacceptable risk)	Risk cannot be justified. Eliminate or mitigate risk. Reduce risk to ALARP Level using risk controls.	Work is NOT to be carried out. Contact Company for assistance/further assessment.
Medium Risk (Tolerable risk)	Eliminate, mitigate risk, or wear protective equipment. Risk to be in ALARP level. Tolerable only if further risk reduction is impracticable.	Work is Possible (with conditions). Control measures to be monitored. Shore assistance may be sought in cases when only inadequate risk reduction is possible on board.
Low Risk (Broadly acceptable risk)	Manage by documented procedures. Monitor progress. Maintain assurance that risk remains at this level.	Work is permitted provided conditions do not change requiring a reassessment of the Risk.

The benefits of using the Risk Assessment performed by crew on board are as follows:

- minimizing the risk of hazardous situations for people, the environment and private property,
- improving the quality of work,
- improving the awareness of ship crew members, orienting ship crews towards safety,
- improving the image of the shipping company as safety-oriented in the broad sense.

Risk assessments should be undertaken by (Balmat et al., 2009; LRS, 2006; BS, 2007):

- people with appropriate operational experience,
- old and young crew members, which combine experience with objectivity and avoid of routine,
- small teams of 2-3 people.

Risk Assessments performed on board the ship related to a specific activity, work or task related to with danger should be collected in the company data banks as examples of Generic Risk Assessments. Such exemplary risk assessments can be readily adopted on sister ships when performing similar tasks after analysing that the risks have not been changed.

Conclusion

1. Procedures for risk management on board sea going vessels are quite complicated for most crew on board sea -going vessels. Management of risk based on risk assessment to be simplify and unified. Suggestion is given to unify procedures for risk assessment.
2. Risk management is a new topic with which ship crews must, become familiar with and then apply in order to reduce the number of accidents in the fleet. If the understanding of the problem is not correct, risk management becomes a worthless process and becomes pure bureaucracy.

3. At the initial stage of introducing risk management on ships, the number of opponents to this process was greater than the supporters. Currently, it can be observed that the understanding of the problem is greater and the favor of the sailing crews is greater, which does not mean satisfactory. Ship crews require training in risk management and these training must be taken as priority.
4. Research done by authors on Risk management showed that approach to risk management and requirements to perform risk assessment are varied between shipping companies
5. Implementation in real practice pro-active Risk Management will reduce of risk to happen undesired events and mitigations of hazards associated with day-to-day operation of sea-going vessels.
6. Research done by authors on Risk management in shipping companies showed that modification of risk assessments procedures must be recommended to some shipping companies to improve safety on board due to applied unclear procedures.

Acknowledgments

This research outcome has been achieved under the research project no. 1/S/KE/2022 financed from a subsidy of the Polish Ministry of Educations and Science for activities of Maritime University of Szczecin.

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