Ocean Systems Engineering, *Vol. 4, No. 2 (2014) 137-150*
DOI: http://dx.doi.org/10.12989/ose.2014.4.2.137

A risk management methodology for maritime logistics and supply chain applications

Kambiz Mokhtari and Jun Ren*

Liverpool Logistics, Offshore and Marine (LOOM) Research Institute, School of Engineering, Technology and Maritime Operations, Liverpool John Moores University, UK

(Received December 19, 2013, Revised April 25, 2014, Accepted May 30, 2014)

Abstract. In the marine industry although there has been significant growth towards safety, security and risk assessments or risk-based strategies such as marine insurance and regulations to avoid the risks of damage to properties and the environment or the prospect of premature death caused by accidents etc, the moves toward managing the risks which are linked directly to the business functions and decision making processes have been very slow. Furthermore in the marine industry most perceptions, methodologies and frameworks of dealing with hazards, risks, safety and security issues are for their assessment rather than their management. This trend reveals the fact that in different marine industry sectors such as logistics and shipping there is a lack of coherent risk management framework or methodology from which to understand the risk-based decisions especially for the purpose of design, construction, operation, management and even decommissioning of the marine related applications. On the other hand risk management is not yet viewed holistically in the marine industry in order to, for example, assign a right person, i.e. risk manager, who can act as a coordinator and advisor with responsibilities that are only specific to risk management. As a result this paper, by examining the present physical borders and risk-based activities in the marine industry, aims to propose an appropriate risk management methodology in addition to the emergent role of risk managers which will enable the industry users initially to become familiar with the concept of risk management at its holistic level. In the later stages this eventually can lead to development of risk management capabilities at an exclusive level and its integration into the marine industry functions in future.

Keywords: maritime logistics; supply chain management; port operations; risk management

1. Introduction

1.1 An overview of the Risk Management (RM)

The principle of RM may be traced to 2250 BC when the Babylonians established a principle called Bottomry as a method of handling the risks associated with international trade (Trenerry 1926). In another instance one of the earliest recorded of RM is the marine insurance arrangements that were drawn up by Phoenician traders more than 3000 years ago (Brown 1998). Indeed both individuals and firms have been informally dealing with risk for thousands of years. Yet, regardless of the occurrence of risk in society, academic interest in the area of RM has only begun

*Corresponding author, Dr., E-mail: j.ren@ljmu.ac.uk

http://www.techno-press.org/?journal=ose&subpage=7 ISSN: 2093-6702 (Print), 2093-677X (Online)

quite recently. In fact the “birth” of the discipline can largely be traced back to only the late 1950s and early 1960s, since it was not until this time that a formal definition of “corporate risk management’’ was developed or indeed widely accepted (Snider 1991, Williams *et al*. 1995).

In earlier definitions the main purpose of the RM was its insurance buying function in order to avoid the “pure risk” e.g., piracy, theft, storms and etc. Pure risk exists when there is uncertainty as to whether loss will occur. No possibility of gain is presented by pure risk – only the potential for loss. Other examples of pure risk include the uncertainty of damage to property by fire, flood or the prospect of premature death caused by accident or illness (Trieschmann *et al*. 2001). Furthermore, pure risks were typically seen as being non-business risks in that they were more an unfortunate by-product of a firm's manufacture of goods and services rather than an integral part of the production process (Carterand and Crockford 1974, Mehrand and Hedges 1974). In contrast to pure risk, “speculative risk” exists when there is uncertainty about an event that could produce either a profit or loss. Business ventures and investment decisions are examples of situations involving speculative risk (Trieschmann *et al*. 2001). In another word it mostly involves with business related risks and decision making processes.

However, during the end of 20th century and at the beginning of the 21st century research into corporate RM has moved along away from emphasising the importance of the insurance buying and pure risk avoidance. There are new emergent reviews of the development in both practical interest and academic research into the field of RM which have been carried out by the era researchers. However they have introduced two key insights to facilitate the RM development. The first one is the achievement of integrated RM as “when RM is integrated (or embedded) into all of the functions and processes within the organisation” (AIRMIC 1999). This addresses not just insurable pure risks but also all other types of risks (i.e., speculative risks) that a firm, corporate or organisation can face e.g. financial risks, country risks, operational risks, organisational risks, business risks etc. The second one is taking a strategic management approach to RM development (CFO Research Services 2002, Johnson and Scholes 2002). In this respect Williams *et al*. (1995) define RM as: “a general function that seeks to identify, assess, and address the causes and effects of uncertainty and risk on an organisation”. They then go on to say that “the purpose of RM is to enable an organisation to progress toward its goals and objectives in the most direct, efficient, and effective path”.

Eventually as per AIRMIC, ALARM and IRM (2002), RM is a central part of any organisation’s strategic management. “It is the process whereby organisations methodically address the risks attaching to their activities with the goal of achieving sustained benefit within each activity and across the portfolio of all activities. The focus of good RM is the identification and treatment of these risks. They argue that RM should be a continuous and developing process which runs throughout the organisation’s strategy and the implementation of that strategy. It should address methodically all the risks surrounding the organisation’s activities past, present and in particular, future. Moreover, RM must be integrated into the culture of the organisation with an effective policy and a programme led by the most senior management. It must translate the strategy into tactical and operational objectives, assigning responsibility throughout the organisation with each manager and employee responsible for the management of risk as part of their job description. It supports accountability, performance measurement and reward, thus promoting operational efficiency at all levels” (IRM 2002).

2. A brief literature review on the marine industry section

In order to review the risk-based issues in the marine industry it is useful to discuss them according to the existing physical borders. Obviously these borders can extend from inland terminals or dry ports inside coastal or land locked states up to the other locations beyond the oceans. Fig. 1 simply illustrates these boundaries in the marine industry.

In the process industry, process operations are the most hazardous activities next to the transportation and drilling operations on onshore or offshore oil and gas platforms. Past experiences of onshore and offshore oil and gas activities have revealed that a small mis-happening in the process operation might escalate to a catastrophe. This is of particular concern especially in the offshore platform due to the limited space and compact geometry of the process area, less ventilation, and difficult escape routes (Krishna *et al*. 2003). In the onshore sector a refinery plant located near a coast line or a port is engaged with marine related activities such as transportation of the products by pipelines or tanker ships via oil terminals therefore, it will be categorised under the marine industry sector. In the offshore sector of the process industry there are also many types of floating production systems and units e.g., Floating, Production, Storage and Offloading (FPSO) units i.e., large, permanently moored oil tankers that have an oil and gas processing facility mounted onto their decks. Oil from subsea wells is piped on board the FPSO through flexible flow-lines, and is processed before being stored in the FPSO’s cargo tank. The oil can then be discharged, through flexible hoses, into an offloading oil tanker vessel. Normally FPSOs are employed in areas of deeper water such as Gulf of Mexico, West Africa, Australia and Brazil (Mather 2009). Among the various installations or rig/vessel types used in the process industry in this paper FPSO is used as an example, due to the fact of its double nature of being an offshore processing facility, and also a vessel. It can also replace a conventional platform in its entirety. However as it can be seen the process industry can extend from a plant refinery and through onshore and offshore (subsea) pipelines to floating platforms or units such as a FPSO moored in middle of the sea.

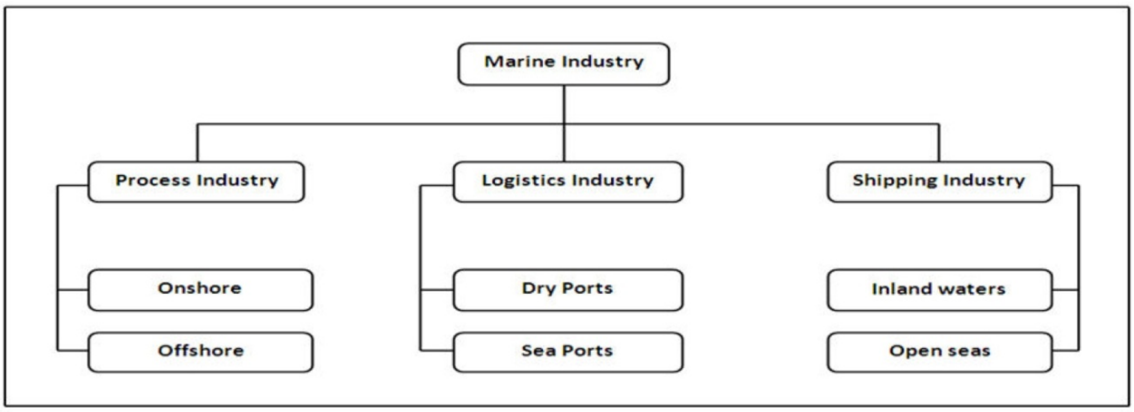

Fig. 1 Segments in the marine industry

Based on various sources (ABS 2000, Maclachlan 2004, Mather 2009, OCIMF 2004, Sutton 2010, UKHSE 2010) there is literature in the offshore industry which mainly relates to the legislation and safety acts such as Mineral Working Act (MWA) 1971, Health and Safety at Work Act (HSWA) 1974, Statutory Instrument (SI) Number 289 in 1974 in UK. All of them have discussed comprehensively about the issues such as safety cases and safety reports; Safety Management System (SMS); Formal Safety Assessment (FSA); Health, Safety and Environment (HSE); ISPS Code; safety case regulations; Quantitative Risk Assessment (QRA); the concept of As Low As Reasonably Practicable (ALARP) in judging the level of acceptable risk. Moreover in onshore process sectors, risk-based process activities and safety aspects are discussed mainly under integrity management, safety and reliability management or engineering (Sutton 2010). None of them have described at a holistic level for a generic or even specific RM methodology or framework which consequently could encompass all the above mentioned issues. Conversely phrases such as hazards, safety, security, reliability, disaster, emergency, and crisis can all be categorised under the phrase of “risk” itself and even phrases such as identification, assessment, evaluation, analysis, mitigation, control, audits, inspection, review and reports also can be considered as subcategories for the phrase of “management”. Therefore using a phrase of “RM” alone can justify these scattered impressions.

In the logistics industry port as a major component of the maritime industry has an important role to play in world trade, international logistics and global supply chains. In respect of the modern seaports presently there are two main dimensions: ports as trade gateways and corridors and ports as logistics and distribution centres (ICS 2007). In present situation as the ocean freight transport commerce has changed its structure as a result of the new trends and preconditions that came with the introduction of the container and the rise of intermodality (Jarzemskis and Vasiliauskas 2007). Therefore the main problems seaports face today, as a result of growing containerised transport, are lack of pace at seaport terminals and growing congestion on the access routes serving their terminals (Woxenius *et al*. 2004). Furthermore in many places around the world, bimodal and trimodal inland terminals (barge, rail, and road) have become inherent parts of the transport system, particularly in regions having a high reliance on trade. In this respect transport development is gradually shifting inland after a phase that focused on the development of port terminals and maritime shipping networks. There are many reasons for this growing attention. The complexity of modern freight distribution and the increased focus on intermodal transport solutions and capacity issues appear to be the main drivers. In addition ESCAP (2009) explain the massification (i.e., economies of scale through larger volumes) of the flows in networks, through a concentration of cargo on a limited set of ports of call and associated trunk lines to the hinterland. This has also created the right conditions for nodes to appear along and at the end of these trunk lines. These nodes in the hinterland networks of ports have been referred to as dry ports, inland terminals, inland ports, inland hubs, inland logistics centres, inland freight villages, etc. As a result inland terminals have become an intermodal and freight distribution unit that comes into three major functional categories. They can be maritime barge terminals serviced from deep-sea ports, intermodal rail terminals linked to gateways and distribution centres linking supply chains. In addition inland ports are commonly incorporating terminals (rail, barge or in rare cases both) with distribution centres in operational characteristics mainly associated with satellite terminals or load centres. The above mentioned facts justify and support the inland terminals or dry port concept as an integrated part of a marine industry and logistics system in maritime business especially for port customers and users (shippers, shipowners, agents, freight forwarders, exporters and importers) to outsource their functions which will need a lot of territory with the cheaper hinterland locations.

As discussed for the process industry, in port sectors there also exists literature (e.g., UNCTAD 1976, 1993, Trbojevic and Carr 2000, DETR 2000, PMSC 2001, ISPS Code 2003, OCIMF 2004, ICS 2007, World Bank 2007, DNV 2010) on legislation, safety and security issues for ports and terminals such as Port Marine Safety Code (PMSC); International Ship and Port Facility Security (ISPS) Code; Port State Control (PSC); Health and Safety at Work Act (HASWA) 1974; International Maritime Organization (IMO) Conventions e.g., SOLAS 1974 and MARPOL 73/78; Pilotage Act 1987, Port Act 1991, and Dock Regulations 1988. Most of them discuss security, health, safety and environmental protection topics rather than the risk itself. On very rare occasions, development of the RM for the purpose of sea ports and terminals has been specifically discussed, for example by GAO (2006) and UNCTAD (2006).

International shipping is a highly competitive industry that provides a crucial service for society through the economic transportation of goods and passengers by merchant ships between ports and terminals via inland waterways such as canals, channels, rivers and open seas. As there are many stakeholders, it is essential to have agreed and shared regulations. For example, shipping is a capital-intensive industry and companies need to finance their operations. This finance largely comes from banks that derive their own finance from loans and the investments of their shareholders. Banks and their shareholders need a rule-based system to protect their risks. Similarly the carriage of cargo depends upon well-tested contracts and proficiency, which in turn are used to determine the outcome of an insurance claim in the event of loss or damage. Seafarers are also bound by contracts of employment and owners have obligations to provide seaworthy ships. Not only does this cover the physical condition of the vessels but the human element, the manning and qualifications of the crew, navigational outfit, fire protection, life-saving capability and watertight integrity. Ships have to enter and work in ports. They require pilots, stevedores, shipyards and dry docks; they need services, stores, bunkers and water. Seafarers themselves become visitors with immigration and health controls, which are quite widely different in the various countries they visit. Customs also have a direct interest on ships, their cargo, crew and passengers for custom duties, smuggled goods and drugs. Therefore, there is an understanding that the shipping is used for many purposes. However there are other challenges such as new regulations, like the ISM Code do not yet have a body law tested in court concerning the commercial consequences of mismanagement and governments have not yet involved their statutory powers, so interpretation of specific clauses may lack precise definition. Operators, however, have to manage and run their ships and shipmasters in particular have to be responsive to their legal obligations (Maclachlan 2004).

In the shipping industry and based on the available literature from several sources (ABS 2000, Maclachlan 2004, ICS 2006, NE P&I Club 2008), rules and regulations or safety and security issues have been discussed in detail. Among them there are topics such as marine insurance, including Hull and Machinery (H&M), Protection and Indemnity (P&I), Freight, Demurrage and Defence (FD&D), War risk and Strike insurances; International Labour Organization (ILO) and Maritime Organization (IMO); Conventions e.g., SOLAS 1974 and MARPOL 73/78; ISM and ISPS Codes; Collision avoidance regulations i.e., COLERG and International Maritime Dangerous Goods (IMDG) Code. They mostly emphasize on health, safety, security and environmental protection issues. Some of them, such as COLERG, are designed for the purpose of preventing a risk of collision. Insurance covers are being used for risk transferring purposes of the pure risks (i.e., uncertainty of damage to property by fire, flood or the prospect of premature death caused by accidents) rather than the speculative risks (i.e., risks which are linked directly to the business function, decision making processes and management). In fact there is a lack of development and integration of the RM perception within the shipping industry as well.

In terms of legislation in practice, the marine industry has suffered a lot and in the past produced disjointed, conflicting regulations, mainly in response to disasters involving considerable loss of life, culminating in the destruction of the Piper Alpha installation in UK waters in 1988. Based on Mather (2000) the Piper Alpha tragedy proved to be the catalyst for a radical change in the way the industry was both certified and regulated. The accident in the Gulf of Mexico which was the explosion on 20 April 2010 on board the Deepwater Horizon, an offshore drilling platform working on a well one mile below the surface of the Gulf of Mexico, has led to a major oil spill (TNYT 2010). Lack of compliance with safety practice and mistakes in proper inspections have been found as main root causes for both cases. Still no one has argued for lack of complying with a generic or any specific RM methodology. They are only interested to put the blame on each other.

3. A proposed RM methodology for maritime logistics and supply chain management

Based on the above summaries it can be seen that there are different risk-based expressions and eventually all are used in these three sectors of the marine industry to identify, assess/evaluate/analyse and mitigate the impact of risk factors that are threatening the marine industry. Furthermore as it can be seen there are many regulatory bodies and other responsible individuals internationally involved in the industry whose main purposes are to avoid and prevent different hazards or risk factors and/or to take preventive and corrective actions. More or less all of them are trying to manage or control existing or probable hazards or risk factors and somehow by using the risk-based related terms and application of some mitigation methods are trying to justify that they were involved in a RM related processes but eventually none of them are using a generic or a holistic RM methodology or framework. This cannot be seen even in regulatory applications. In its advanced form a QRA method, or even the FSA methodology produced by IMO applicable in offshore and shipping industries are used in the offshore side of the oil, gas and process industries for the purpose of safety cases to identify, evaluate and mitigate the hazards,. The first one uses the words ‘quantitative risk assessment’ but utilises hazard identification, risk evaluation, risk mitigation phases within its methodology. These steps are steps of a RM methodology. In the second one i.e., ‘formal safety assessment’ also the steps are hazard identification, risk assessment, risk mitigations, cost/benefit analysis and recommendation respectively which justify being steps of a RM methodology. Still many players in the marine industry are not well familiar with a RM framework, its proper definition and methodology.

Furthermore as it was discussed in the introduction it is a key issue that RM to be embedded and integrated into the functions of the organisations as well as the decision of taking a strategic management approach to RM development within organisations. For this reason in this paper and for the purpose of marine industry applications and in order to overcome all the mentioned insufficiencies a holistic and generic methodology for RM has been introduced. This reinvention in the marine industry can be an optimum solution to cover all the mentioned deficiencies. The dictionary typically defines ‘‘holistic’’ as dealing with wholeness rather than focusing on its parts or different sides or viewpoints. In fact the term of ‘‘holistic RM’’ can be used in the simple sense for the management of all sources of risk (Hopkin 2002). Miller and Waller (2003) clearly regard this as a necessary part of their view of integrated RM as they state: ‘‘the essence of integrated RM is consideration of the full range of uncertain contingencies affecting business performance''. However, in its proper sense, 'holistic' implies a systemic perspective, which recognises system properties that are distinct from the properties of system components. In this sense, holistic RM would imply recognition and management of interactive effects between organisation activities and associated risks (Ward 2005, Ren *et al*. 2007, Ren *et al*. 2008). In another instance linking the concept of enterprise-wide, holistic and integrated approaches Deloach (2000) defines enterprise-wide RM as meaning that: "a truly holistic, integrated, forward looking and process oriented approach is taken to manage all key business risks and opportunities – not just financial ones – with the intent of maximising shareholders' value for the enterprise as a whole". So a clear understanding of the terms in RM is important and a clear methodology essential to ensure for a strong framework. As a result a proposed framework as shown in Fig. 2 is used to describe a generic methodology that can develop a RM capability by enhancing a holistic RM view within the marine industry. In this regard the RM framework for the marine industry can be discussed through the following phases:

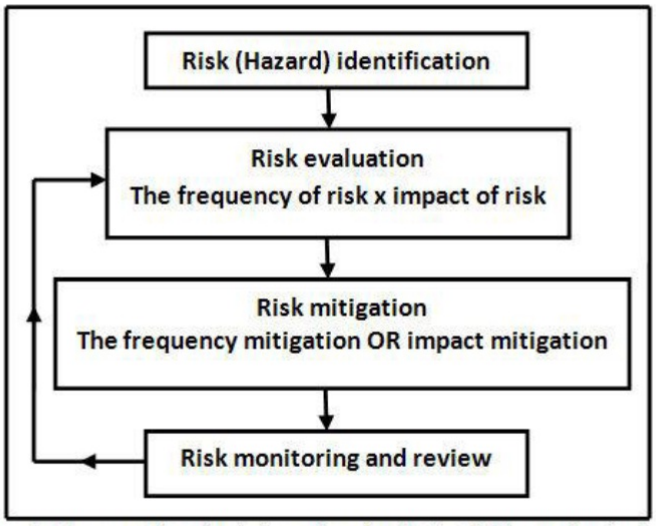

Fig. 2 Proposed methodology for a holistic RM in marine industry

3.1 Risk (Hazard) identification

The first phase in any RM cycle is risk identification or HAZID (HAZard Identification) process (World Bank 2007, GAO 2006, UNCTAD 2006, IRM 2002, DETR 2000). "Risk identification should be approached in a methodical way to ensure that all significant activities within the organisation have been identified and all the risk factors flowing from these activities are defined" (IRM 2002). In this respect although in general terms as it is discussed earlier, many firms, organisations and government bodies are using the phrase "risk identification" for the first phase in their RM processes but more particularly in engineering and industrial sectors such as in marine and offshore systems (ABS 2000, Pillay and Wang 2003, Wang and Trbojevic 2007, Ren *et al*. 2009) the phrase of “HAZID” is used instead of the first one. It has been decided that the phrase of “HAZID” is used in this paper hereafter instead of the phrase, “risk identification”. In this respect HAZID is a general term used to describe an exercise whose goal is to identify hazards and associated events that have the potential to result in a significant impact or consequence. For example, a HAZID of an offshore petroleum facility may be conducted to identify potential hazards which could result in consequences to personnel (e.g., injuries and fatalities), environmental (e.g., oil spills and pollution), and financial assets (e.g. production loss and delays). Moreover a HAZID technique can be applied to all or part of a facility or vessel or even can be applied to analyse operational procedures. Depending upon a system being evaluated and the resources available, the process used to conduct a HAZID can vary (ABS 2003). As ABS (2000, 2003) explains literature search, checklists, Hazard and Operability Study (HAZOP), HAZID and event data sources are hazard identification methods. As an example in ports and terminals especially in oil, LNG and LPG import and export terminals HAZOP is the best solution for hazard identification purposes. In this respect HAZOP is a structured way of examining the planned or existing process operation. The objective of a HAZOP study is to identify problems that may represent risk to personnel or equipment, or prevent efficient operation (Lassen 2008).

3.2 Risk evaluation

The investigation of almost all the major accidents and various losses in terms of delays and costs shows that they could have been avoided with effective RM programmes (Wang 2004). Nevertheless a high quality RM or to a lesser extend a high quality risk evaluation is absolutely necessary for sustainable development. Risk is defined as a measure of human injury, environmental damage or economic loss in terms of both the incident likelihood and the magnitude of the injury, damage or loss (CCPS 1989). Risk evaluation involves the development of an overall estimation of risk by gathering and integrating information about scenarios, frequencies and consequences, and it is one major component of the whole RM process of a particular enterprise. In the process of risk evaluation, both qualitative and quantitative techniques can be used (Krishna *et al*. 2003). However as ABS (2003) discusses the word risk itself specifically is the product of frequency with which an undesirable event is anticipated to occur and the impact of the event’s outcome. In other word risk is composed of two parameters, frequency and impact; that means: Risk = frequency $\times$ impact. Due to the highly subjective nature and lack of information, it is usually difficult to determine risk parameters precisely. A reasonable and suitable way to express these parameters is to use qualitative verbal expressions (i.e., linguistic variables) especially during experts’ judgments. To estimate the occurrence frequency, for example, one may often use such variables as very low, low, medium, high and very high. In addition to estimate the consequence impact also one may often use such variables as slight, minor, moderate, critical and catastrophic. A variety of other techniques have been used for risk evaluation and analysis including Preliminary Hazard Analysis (PHA), Failure Modes and Effects Analysis (FMEA), Fault Tree Analysis (FTA), Event Tree Analysis (ETA), Cause-Consequence Analysis (CCA), Human Reliability Analysis (HRA) (CCPS 1989, Lees 1996, Dickson 2003, ABS 2003, Sutton 2010, Dickson 2003). As Dickson (2003) explains these techniques have all been developed in the industrial setting, normally in response to some practical business problems.

3.3 Risk mitigation

Risk mitigation is a decision making process whereby actions are taken in view of the outcome of risk assessment evaluation or analysis. Standard risk prevention strategies aim either at reducing the probability of an incident (pre-accident intervention) or at minimising the probability of fatalities if the accident occurs (post-accident intervention). This process is generally combined with cost-benefit analysis (CBA) for optimal decision-making (UNCTAD 2006). CBA is the most standard method for identifying the optimum benefit-to-cost ratio, usually by contrasting loss of earnings, or the cost of failure, against the benefits of compliance. In the context of maritime regulations, CBA was first introduced by the FSA guidelines as approved by the IMO in 2001, and later adopted in programmes such as the one used for the regulatory assessment of maritime security (UNCTAD 2006). In another instance IRM (2002) explains that risk treatment is a process of selecting and implementing measures to modify the risk. Risk treatment includes as its major element, risk control/mitigation, but extends further to, for example, risk avoidance, risk transfer, risk financing, etc. Obviously marine insurance is one of the methods and strategies used extensively in the marine industry for risk mitigation purposes. Another example for risk mitigation in the process industry is Safety Integrity Level (SIL) that is a measure of the availability of protection layer or barrier. Protection layers include Basic Process Control System (BPCS), critical alarms and human intervention, Safety Instrumented Functions (SIF), physical protection and emergency response. All these mitigate the frequency of occurrence of the potential unwanted end-consequence or mitigate the impact the end-consequence represents (Lassen 2008). All statutory regulations, classification societies' rules, IMO Conventions and Codes are typical examples of strategies used for the purpose of risk mitigation. There are also many other analytical tools for carrying out the cost-benefit analysis or to select the best strategy if there are more strategies for risk mitigation purposes. Among these methods, the most popular ones that lately were used by researchers are analytic hierarchy process (AHP) (Golec and Taskin 2007), analytic network process (ANP) (ESCAP 2009), axiomatic design (AD) (Kulak and Kahraman 2005), TOPSIS (Kahraman *et al*. 2007), ELECTRE (Wang and Triantaphyllou 2005) and PROMETHEE (Dagdeviren 2008). Ultimately depending on whether to take preventive or corrective actions during the risk mitigation phases of the RM cycles, i.e., whether to decide in proceeding toward proactive or reactive RM approaches, there could be different strategies to be utilised for this purpose which are outside the scope of this paper.

3.4 Risk monitoring and review

As explained previously in order to carry out RM properly and complete the RM cycle, after hazard identification and risk assessment phases by using the concept of ALARP in judging the level of acceptable risk, a risk factor itself will be judged and if it was not acceptable by application of the mitigation strategies it can be controlled and managed. However the utilised strategies in the mitigation phases must be monitored in order to know whether they have affected the risk factors to reduce their effect to an acceptable level or not. Suppose by measuring the amount of ALARP on the time bases if it was evidenced that the used strategies were not effective. Then the utilised strategies must be changed. To carry out the last phase of the RM, SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis is one of the best methods. A SWOT analysis is a commonly used tool for analysing internal and external environments in order to attain a systematic approach and support for a decision situation (Kotler 1988, Wheelen and

Hunger 1995). In a SWOT analysis the internal and external factors are most important to the enterprise's future and are referred to as strategic factors and summarised within the SWOT analysis. Additionally the final goal for any strategic planning process, of which SWOT is an early stage, is to develop and adopt a strategy resulting in a good fit between internal and external factors. SWOT can also be used when a strategic alternative emerges suddenly and the decision context relevant to it has to be analysed. If used correctly, SWOT can provide a good basis for successful strategy formulation (McDonald 1993). Some of the other analytical methods such as AHP (Kurttila *et al*. 2000) can also be used for the purpose of this phase to support and complete the RM cycle.

4. Deployment and role of risk managers in marine industry

In respect of strategy making, Mintzberg (1994) suggests that corporate planners should make their contribution by supporting and facilitating strategic thinking by line managers, rather than driving strategy formulation in a way that reduces management's involvements in the process. Thus Mintzberg explains that planners could usefully contribute to strategy development by acting as "finders of strategies". As Ward (2005) discusses "following this line of argument, risk managers should not be managers of risk at all. They should make their contribution around the RM process rather than inside it, to use more of Mintzberg's terminology". Thus, titles like risk manager, "risk controller'', and even "risk co-ordinator'' may be positively unhelpful, so far as they imply responsibility for RM activity throughout the organisation, as well as responsibility for risk thinking. Yet both of these tasks ought to remain firmly with management. Instead, risk managers can contribute to RM development by acting as "finders of strategies", as "analysts", and as "catalysts", in much the same way as (Mintzberg 1994) "planners can contribute to strategy development". The above three roles are reflected in more specific guidance on the responsibilities of the corporate risk manager from the UK based Association of Insurance and Risk Managers in Commerce (AIRMIC). The AIRMIC suggested that the corporate risk manager should act as a coordinator and advisor with responsibilities to (Butterworth *et al*. 1996):

- Design and establish an integrated RM strategy, philosophy, and policy statement for communication throughout the organisation.
- Establish and maintain a detailed RM methodology appropriate to the company's needs; to include formalised risk (hazard) identification techniques, quantitative and qualitative risk assessment and cost effective methods for risk reduction and transfer.
- Advise business areas on the use of RM techniques.
- Seek best working methods that acknowledge, understand and control risks.
- Monitor the application and effectiveness of RM.
- Co-ordinate the reporting on RM activities to the Board.
- Act as a conduit for the inter-change of information on risk(s) and RM.

The same responsibilities can be used and are applicable for risk managers in the marine industry. As an example in the marine industry and for the case of sea ports it has been evidenced for US ports. Now port authorities are looking for port risk managers who under general direction, should direct and administer the RM programmes of the US ports in accordance with the mission, goals, and objectives as expressed by the Chief Financial Officers. "The port risk manager ensures compliance with federal, state and local ordinances pertaining to, among other things, public liability, special exposure, safety and worker's compensation" (PARMA 2010). In addition, they must ensure that insurance and related funds are available to cover potential losses. At present, in the offshore industry, HSE and in shipping industry insurance managers are responsible for almost the same responsibilities. Nevertheless in future they may change their titles and responsibilities like the one was for port industry. In this regard there are other examples e.g., project risk managers during port developments, port projects, building offshore structures and ships.

5. Conclusions

Port, offshore and shipping industries are essential elements for the operation of every country's economy that can affect their cost structures, industrial competitiveness and living standards. Moreover as discussed earlier there exist sources of uncertainties in marine industry, all of which require attention in respect of their identification, evaluations, mitigation and review with the use of an appropriate RM approach, if this industry is going to be remaining responsive to the strategic needs and future challenges. To achieve this firstly there is a need for RM to be integrated (or embedded) into all of the functions and processes within the marine industry and secondly to take a strategic management approach to RM development within marine industry. However to perform this there is a need at the beginning to become familiar with the methodology of RM in the marine industry at a holistic level. For these reasons an appropriate generic RM methodology for the purpose of marine industry applications is introduced and reviewed in this paper. Furthermore a set of RM-related obligations addressed to be carried out specifically by risk managers to facilitate the proposed RM methodology. This will lead the potential risk-based challenges and sources of uncertainties in the marine industry to be handled efficiently. In future work, industry users by investigating the different methods (quantitative or qualitative) to be carried out in their RM frameworks can choose the best method that can suit their RM decision making processes. In fact this will depend on the type, nature and original sources of risks and uncertainties within the organisations. This means that in respect of the marine industry itself the sources of risks may be are from externally or internally driven sources or whether specifically their nature may could be initiated from risks such as country, business, organisational, operational etc. Furthermore in this competitive industry there are many large organisations in the offshore, port and shipping industries. Sooner or later they should make preparation to face with the newly emergent issues such as security RM, crisis RM, business continuity management and resilience concept.

Acknowledgements

This research was partially supported by the European Regional Development Fund (ERDF) under the Interreg IVB North West Europe Programme (WEAST flows project).

References

ABS, American Bureau Shipping (2000), Risk assessment applications for marine and offshore oil and gas industries.

ABS, American Bureau Shipping (2003), A guide for risk evaluations for the classification of marine-related facilities.

AIRMIC Integrated Risk Management Special Interest Group (1999), A guide to integrated risk management. London: The Association of Insurance and Risk Managers in Commerce.

AIRMIC, ALARM, IRM Standard (2002), A risk management standard. London: AIRMIC, ALARM, IRM.

Brown, R.H. (1998), *Marine insurance: principles and basic practice*, 6th Ed., Witherby Publishing.

Butterworth, M., Reddaway, R. and Benson, T. (1996), Corporate Governance - a guide for insurance and risk managers. London: Association of Insurance and Risk Management.

Carter, R. and Crockford, G. (1974), *Handbook of risk management*, Kluwer Publishing, Kingston, UK.

CCPS, Center for Chemical Process Safety (1989), *Guideline for chemical process quantitative risk analysis*, 1st Ed., New York: Center for Chemical Process Safety, American Institute of Chemical Engineers (AIChE).

CFO Research Services (2002), Strategic risk management- new disciplines, new opportunities, Boston, Mass. CFO publishing Corp.

Dagdeviren, M. (2008), "Decision making in equipment selection: an integrated approach with AHP and PROMETHEE", *J. Intell. Manuf.*, **19**(4), 397-406.

Deloach, J.W. (2000), *Enterprise wide risk management: strategies for linking risk with opportunity*, London: Finance Times/Prentice Hall.

DETR, Department of Transport (2000), *Port marine safety code.* March 2000, ISBN: 1 85112 365 2.

Dickson, G.C.A. (2003), *Risk analysis, The Institution of Risk Management*, IRM, Witherby publishing.

DNV, Det Norsk Veritas (2010), Integrated Management System (IMS) Available at: http://www.dnv.com/ Accessed on: 01.09.2010.

ESCAP, Economic and Social Commission for Asia and the Pacific (2009), Development of dry ports, United Nations, New York.

GAO, United States Government Accountability Office (2006), Port risk management: Further Refinements Needed to Assess Risks and Prioritize Protective Measures at Ports and Other Critical Infrastructure. Report to Congressional Committees.

Golec, A. and Taskin, H. (2007), "Novel methodologies and a comparative study for manufacturing systems performance evaluations", *Inform. Sciences*, **177**, 5253-5274.

Hopkin, P. (2002), *Holistic risk management in practice*, London: Witherby&Co.Ltd. ISBN: 1 85609 207 5.

ICS (2006), Shipping Business. The institute of chartered Shipbrokers, UK.

ICS (2007), Port and Terminal Operations and Management. The institute of chartered Shipbrokers, UK.

IRM, The Institute of Risk Management. (2002), A standard for risk management, www.theirm.org.

ISPS Code (2003), International Ship and Port Facility Security Code, SOLAS Amendments adopted on 12 December 2002. IMO London.

Jarzemskis, A. and Vasiliauskas, A.V. (2007), Research on dry port concept as intermodal node.

Johnson, G. and Scholes, K. (2002), *Exploring corporate strategy*, 6th Ed., Harlow: Pearson Education Ltd.

Kahraman, C., Buyukozkan, G. and Ates, N.Y. (2007), "A two phase multi-attribute decision making approach for new product introduction", *Inform. Sciences*, **177**(7), 1567-1582.

Khan, F.I., Sadiq, R. and Husain, T. (2002), "Risk-based process safety assessment and control measures design for offshore process facilities", *J. Hazard. Mater.*, **94**(1), 1-36.

Kotler, P. (1988), *Marketing management: analysis, planning, implementation, and control*, 6th Ed., Prentice-Hall International Edition.

Krishna, K., Wang, Y., Saraf, S.R., Rogers, W.J., Baldwin, J.T., Gupta, J.P. and Mannan, M.S. (2003), "Hydroxylamine production: Will a QRA help you decide?", *Reliab. Eng. Syst. Safe.*, **81**(2), 215-224.

Kulak, O. and Kahraman, C. (2005), "Fuzzy multi-attribute selection among transportation companies using axiomatic design and analytic hierarchy process", *Inform. Sciences*, **170**(2-4), 191-210.

Kurttila, M., Pesonen, M., Kangas, J. and Kajanus, M. (2000), "Utilizing the Analytic Hierarchy Process (AHP) in SWOT analysis a hybrid method and its application to a forest-certification case", *Forest Policy Econ.*, **1**(1), 41-52.

Lassen, C.A. (2008), *Layer of protection analysis (LOPA) for determination of safety integrity level (SIL)*, Norwegian University of Science and Technology. MSc Thesis.

Lees, F.P. (1996), *Loss prevention in the process industries*. 2nd Ed., Boston.

Maclachlan, M. (2004), *The shipmaster's business companion*, Published by the nautical institute, 4th Ed., ISBNN: 1870077458.

Mather, A. (2009), FPSO Handbook. Witherby seamanship international Ltd. ISBN: 9781905331574.

Mather, A. (2000), *Offshore engineering, an introduction*, 2nd Ed., Witherby seamanship international Ltd. ISBN: 1856091864.

McDonald, M.H.B. (1993), The Marketing Planner. Butterworth- Heinemann, Oxford.

Mehr, R. and Hedges, B. (1974), Risk Management: Concepts and Applications. Irwin.

Miller, K.D. and Waller, H.C. (2003), "Scenario, real options and integrated risk management", *Long range planning*, **36**, 93-107.

Mintzberg, H. (1994), The rise and fall of strategic planning. Hemel Hempstead, Herts: Prentice Hall International (UK) Ltd.

NE P&I Club (2008), An introduction to P&I insurance and loss prevention, Loss prevention guide.

OCIMF (2004), *Marine terminal baseline criteria and assessment questionnaire. Oil companies international marine forum*, 1st Ed., Steamship international. Witherby publishing.

PARMA (2010), Available At: http://www.parma.com/jobpost_details.cfm?jobid=1065 Accessed on 05.09.2010.

Pillay, A. and Wang, J. (2003), *Technology and safety of marine system*, Elsevier ocean engineering book series. ISBN: 0 08 0441483.

PMSC, Port Marine Safety Code (2001), Chichester harbour conservancy, 1st Dec. 2001.

Ren, J., Wang, J., Jenkinson, I., Xu, D.L. and Yang J.B. (2007), "A Bayesian network approach for offshore risk analysis through linguistic variables", *China Ocean Eng*., **21**(3), 371-388.

Ren, J., Jenkinson, I., Wang, J., Xu, D.L., Yang, J.B. (2008), "A methodology to model causal relationships on offshore safety assessment focusing on human and organisational factors", *J. Safety Res*., **39**(1), 87-100.

Ren, J., Jenkinson, I., Wang, J., Xu, D.L. and Yang, J.B. (2009), "An offshore risk analysis method using fuzzy Bayesian network", *J. Offshore Mech. Arct*., **13**(1), 041101-1-12.

Snider, H. (1991), Risk Management: A Retrospective View. Risk Management, April.

Sutton, I. (2010), Process risk and reliability management. Operational integrity management. Published by Elsevier Inc. ISBN: 9781437778052.

TNYT, The New York Times (2010), Gulf of Mexico Oil Spill, 2010 Available At: http://topics.nytimes.com/top/reference/timestopics/subjects/o/oil_spills/gulf_of_mexico_2010/index.html Accessed on 05.09.2010.

Trbojevic, V.M. and Carr, B. J. (2000), "Risk based methodology for safety improvements in ports", *J. Hazard. Mater*., **71**, 467-480.

Trenerry, C.F. (1926), The Origin and Early History of Insurance: Including the Contract of Bottomry.

Trieschmann, J.S., Gustavson, S.G. and Hoyt, R.E. (2001), Risk Management and Insuramnce.11 Ed. South-Western College Publishing. Thomson Learning.

UKHSE, United Kingdom Health and Safety Executive (2010), Available at: http://www.hse.gov.uk/index.htm Accessed on: 15.01.2010.

UNCTAD (1976), port performance indicators. TD/B/C.4/131/Supp.1/Rev.1.

UNCTAD (1993), Legal aspect of port management Reported by the UNCTAD secretariat. UNCTAD/SHIP/639.

UNCTAD (2006), Marine security: elements of an analytical framework for compliance measurement and risk assessment. New York and Geneva, 2006. UNCTAD/SDTE/TLB/2005/4.

Wang, J. and Trbojevic, V. (2007), *Design for safety of marine and offshore systems*, IMarEST, ISBN: 1-902536-58-4.

Wang, X. and Triantaphyllou, E. (2005), *Ranking irregularities when evaluating alternatives by using some ELECTRE methods*, OMEGA. doi:10.1016/j.omega. 2005.12.003.

Wang, Y. (2004), *Development of a computer-aided fault tree synthesis methodology for quantitative risk analysis in the chemical process industry*, PhD thesis, Texas A&M University

Ward, S. (2005), Risk management organization and context.

Wheelen, T.L. and Hunger, J.D. (1995), *Strategic management and business Policy*, 5th Ed., Addison Wesley, Reading, MA.

Williams, C., Smith, M. and Young, P. (1995), *Risk management and insurance*, 7th Ed., Mc-Graw Hill International, New York.

World Bank (2007), *The international bank for reconstruction and development*. Port Reform Toolkit. 2nd Ed.

Woxenius, J., Roso, V. and Lumsden, K. (2004), "The dry port concept – connecting seaports with their hinterland by rail", *Proceedings of the 1st International Conference on Logistics Strategy for Ports*. China, Dalian.

Yuksel, I. and Dagdeviren, M. (2007), "Using the analytic network process (ANP) in a SWOT analysis – A case study for a textile firm", *Inform. Sciences*, **177**, 3364-3382.