Middlesex University

Middlesex University of London
National Centre for Work Based Learning Partnerships

DOCTORATE IN PROFESSIONAL STUDIES
(MARITIME RISK MANAGEMENT)

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TITLE: INTEGRATED AUDITING SYSTEM FOR MARITIME RISK MANAGEMENT (IASMAR PROJECT)

Konstantinos Rokkos
Student ID 2144036
MODULE 5140
June 2006

A PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR IN PROFESSIONAL STUDIES

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This book is dedicated to
Elli, Elli Maria and Sandra
for their love and encouragement
throughout my Doctoral studies.

INTEGRATING AUDITING SYSTEM

FOR

MARITIME RISK MANAGEMENT (IASMAR)

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Acknowledgments

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Thank you all.

Abstract

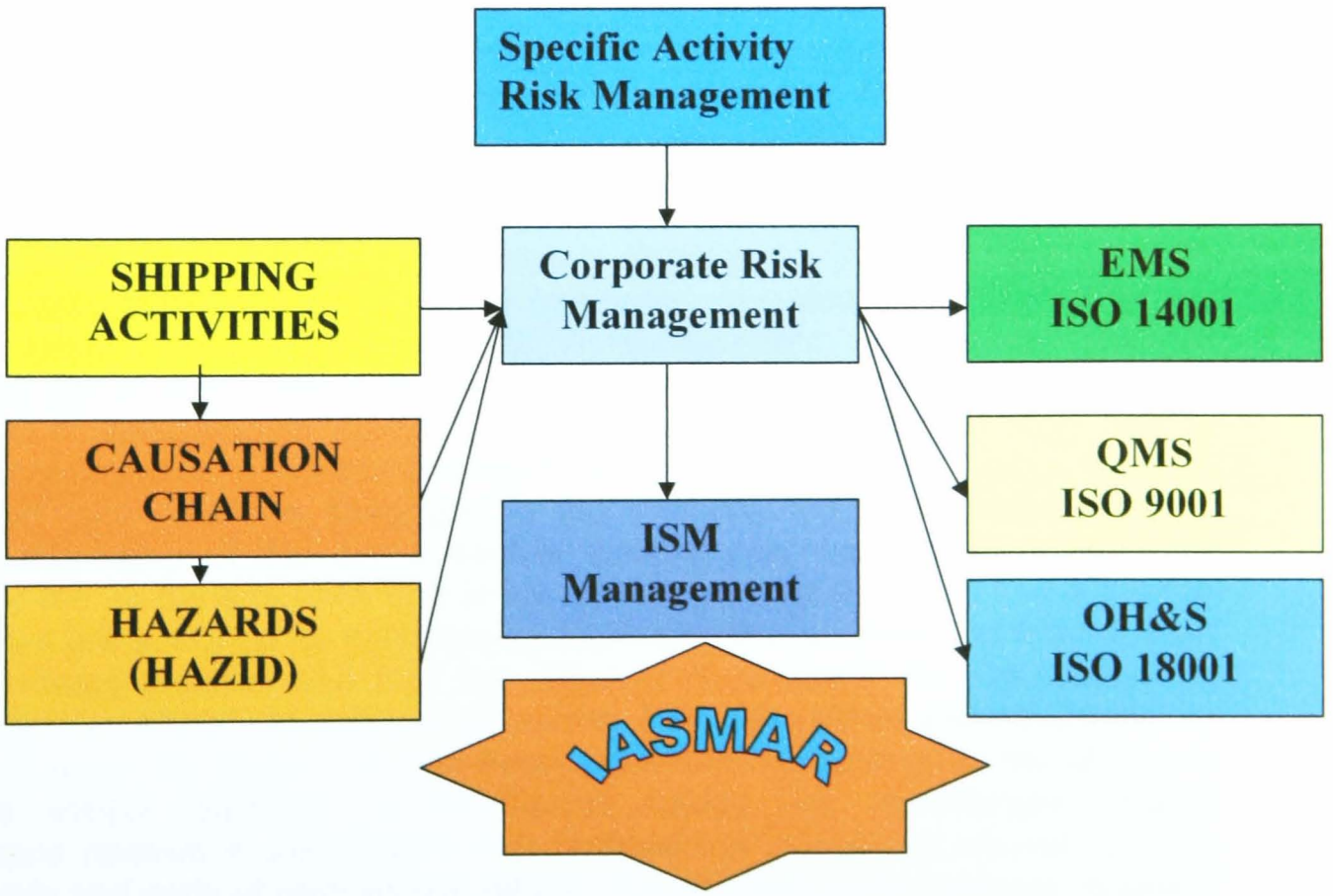
There has been an increasing recent work in the assessment of risk in the maritime transportation systems. Maritime transportation of goods (solid or liquid) has been since ancient times the main way of interrelation between nations and people and has given relatively substantial development in economic and financial growth. Risk is inherent in the marine transportation systems due to highly unpredictable multi functional operation in which uncertainties are very difficult to be optimized. The presence of uncertainty in maritime activities is well recognized and two types of uncertainty considered for ship operations, aleatory uncertainty, which represents the randomness of the system itself including conditions and working factors, and epistemic uncertainty, which represents the lack of knowledge about the system including human factors. This paper explores the challenges of a decision making risk modelling tool for Specific Activity Risk Management as well as for Corporate Risk Management and develops a systematic way for quantification and valuation of risk levels through a ranking and an auditing method of shipping activities and implemented SQEOH management systems core elements respectively. The paper concludes to the proposal of an Integrated Risk Management System (IRMS) plan based on a) auditing of a weighted matrix of 20 Critical Core Elements (CCE) for Corporate Risk Management (CRM) which will identify weak risk level areas and enhance effectively and cost efficiently control options of Maritime Management for reducing level of risk at all stages, and b) by risk correlation and ranking of the shipping activities as a Specific Activity (SAR) risk assessment with associated causes categories and risk index level so as an integrated auditing and ranking system is created for maritime risk management (IASMAR). The main merit of this work is the development of a risk management plan in a systematic way based on identified shipping activities with associated causes and hazards and core elements of implemented management system standards for quality (ISO 9001), safety of crew (ISM, OHSAS 18001) and ship (ISM), environmental protection (ISO 14001) and occupational health (OHSAS 18001) in order to model the correlated uncertainties for the assessment of Corporate risk (CRM) and Specific Activity risk (SIR) in a hierarchical, sequential and iterative process which will improve results of risk priorities and risk based decision making process (RBDM) in relation to consequences for severity level to Property, Human life and Environment. Possibility and actuality of cause correlation with risk indexes improves the quality characteristics of risk assessment and provide an alternative reliable interpretation of traditional determination of likelihood or frequency index by taking causes parameters in to consideration in order to be able to compare and evaluate them to select the best alternative. The developed system is a tool that assists ship managers (decision makers) in managing their risks of maritime activities systematically in real world and reduces their potential losses for specific activities or in corporate management level or combined.

Its use by Ship managers, operators and employees will improve considerably "risk awareness and safety culture" and will develop sufficient knowledge and understanding of how to create an inventory of Shipping activities could lead to an incident in terms of perceived risk, to identify associated hazards (HAZID) and finally to evaluate and manage the risks and prioritize the risk control options (RCO) in order avoid /eliminate/ mitigate consequences and to predict causes

categories which are important mainly contributing to accidents in marine transportation systems resulting severe environmental damage and large-scale loss of life. This new culture introduced promotes in general the duty of care in safety, quality, environmental, occupational health and safety issues to ship and shore personnel.

IASMAR was developed as a method of decision modelling that would be compatible with maritime implemented and activity, task and goal oriented management system for which specific critical activity and corporate risk management integrated and provide a feasible and effective decision making process timely supported for improving cost saving, adopting new requirements and handling successfully liabilities for crew and ship's property. It is also a self-assessment plan based on core elements affecting risk awareness and management implementation in combination with corporate experience and performance levels for problem solving of preventive or mitigating plans and providing a risk based decision modelling in action and in real world for demonstrating continuous improvement in implemented management systems. IASMAR is a plan, which quantifies and predicts the area and causation chain of an undesired event resulting from loss control or oversights and omissions within the management system. The correlation between the determined risk success score, the risk reduction level and the possibility of an event clearly defines the use in prediction of incidents and consequently the risk reduction. Various stakeholders are interested for that and its benefits such as Ship-owners, Charterers, Insurance companies, Financial organisations, P+I clubs, Port authorities, Flag states and suppliers. The IASMAR project-rating index developed under the guidance and within the forthcoming implementation of Formal Safety Assessment (FSA) and possibility theory.

MARITIME INTEGRATED RISK BASED MANAGEMENT



Executive Summary

The" integrated auditing system for maritime risk management" IASMAR is a risk management plan for identifying, modelling, evaluating and monitoring risks as of specific shipping activity or in a corporate management system. Up to now managers or officers in shipping companies rarely quantify uncertainty and systematically assess the risk involved in an activity. Furthermore, even if risk is addressed, it is even less frequently used systematically the evaluation and quantification of risk involved and the magnitude of severity for consequences associated with this risks and liabilities. IASMAR provided an integrated system for both shipping activities and management system which will offer a systematic approach by analysing and quantifying risks in specific shipping and shipboard activities as well as to establish a corporate risk management system as an add-in system by using 20 core elements of the existed implemented management system like ISM mandatory or the voluntarily QMS as per ISO 9001:2000 or EMS as per ISO 14001:2004 or as per OHSAS 18001:2000 and Risk Management. Additionally will establish a combination of possibility and actuality of cause's categories in a form of success risk index and risk index level additionally for safety, quality, environmental and occupational health values by weighting core management elements and risk factors both within the multivariable regression model. The implementation of IASMAR will assist the shipping industry to accomplish its safety and quality objectives by bringing a systematic, disciplined approach to evaluate and improve the effectiveness of risk management, control, and operational processes. It will assist also to improve confidence of the way of allocating resources by the management and will improve financial growth by reducing cost of incidents, reduction in premiums and improvement of revenues by promoting higher standards among competition with similar companies. The specialised work of this project in the integrated auditing system for risk management has been implemented and combined successfully and practically to the participated companies in the ultimate survey and the shipping activities data correlated successfully with SQEOH management system's associated causes and risk level by a significant contribution of participants data of audits resulted confidence and assignment of risk level for 8 types of ships. The level of predicted risk index for set of variables in SQEOH for all eight types of ships determined, tested and validated by measuring the success of predicting risk index under certain values of SQEOH management systems variables. In addition, the project's research has proved that by testing the conditions of the risk based management system's core elements a correlation found among independent cause of incident probability and IASMAR risk index score, which is adequate and could be integrated in the implemented management system. Within the frame of this aim a flexible auditing plan has been developed to quantify the 20 parts of each one of the 20 defined core elements and a relative risk score pre assigned for each one by assessing the correlation to the risk level of associated hazards and four risk determination criteria for practicality and feasibility, uncertainty to achieve objectives, level of controls and monitoring by using of which an appropriate risk-based methodology developed including any risk or control identified by participants, taking into consideration quality assurance reviews in accordance with professional practice of internal auditing standards and code of professional ethics. The structure of the research is based

to the probability and possibility theory and risk management elements, ISM and ISO codes for quality, safety, environmental and occupational health management system for the Shipping Industry that promotes preventive measures to establish safeguards against all identified risks. The application of action research and soft system methodology has improved the performance level of the risk based SQEOH Management System through investigation and audits, which are based on a control and monitoring loop. The causes of an incident or accident are what everyone wanted to know including public interest and authorities. By implementing IASMAR and by correlating possible and actual causes with risk index in management systems, the completeness of the prudent handling is investigated, and deviations quantified numerically by a risk rating index coefficient which will be used for identification of specific shipboard operational activities needed additional care and weak management areas needed improvement. The enormous complicity of the risk determination process, especially when applied to problems encompassing a number of activities, stakeholders and shipping variable's variations created a vast amount of data which makes imperative that the risk ranking and quantification and auditing should carried out efficiently by using a reliable software tool, in this case MS Analyse it tool pack, in a transparent and systematic manner. It is also the basic premise that the integrated auditing system IASMAR is a tool for supporting the decision making process in day to day operation in a shipping or ship related company for cost efficient and timely decisions. It has also made decision-making process more rational and provide a proactive approach, thus optimising the number of safety control proposals and applications and will justify decision sequence of judicial liabilities and underwriters compensation in case of an accident. Integrated auditing system also provides systematic information on hazards, risks, risk control options, their costs and benefits, in a rational, structured and auditable manner. Therefore, a major organisational change achieved as for every activity within the SQEOH Management System. With IASMAR there is a risk management plan related to hazards, causes, properties, events and consequences and by implementation of IASMAR structured risk management for measurement of improvement performance and records of the results of checks /measurements kept so as developments and needs reviewed properly and measures for reduction or avoidance or transfer of risk is considered reliable, integrated, foreseeable, manageable and competent.

IASMAR rating index produced from a widely diversified data collected by the participants representing the most common commercial used ships and relationship between risk level , risk weak management areas, severity in consequences for property, human and environment. Risk control procedures were examined and recommendation to mediate high risk in areas, which found to be weak in management elements proposed and explained. The IASMAR rating helps a risk management team to quickly analyse the current level of risk in activities and management areas that may affect the corporate risk level and associated liabilities. Nowadays it is clear to all of us in the Shipping community that risk assessment/management is going to be made compulsory as part of the ISM Code to all ship operations starting from the emergency response and contingency plans to the recently implemented Safety Ship Port code. Those prospects will substantially re value the prospects of my research project.

CHAPTER 1: INTRODUCTION

1.1 Introduction

There is a general improvement of the people's interest for the safety, quality and environmental protection issues. It is further clear that safety and environmental protection in shipping is of major concern to both the people and the public. The estimation that more than 1000 lives are lost annually due to ship accidents and from these 400 fatalities are related to work onboard, and the rest lost from illnesses brought recently to the attention the occupational health and hygiene onboard the ships. This is reflecting the standpoint that the present implementation of ISM code and the way it is enforced have definite shortcomings. There are also clear proves following public researches that people are interested to promote companies which can prove that can take serious steps and interest in their activities to improve SQEOH considerations and to reduce risk in their potential hazardous impacts. Risk is a factor that everyone encounters when participating in maritime operations. Decisions made everyday are based upon risk. Usually, decisions are intuitive in nature and rooted in common sense. An appropriate analysis of these risks related to shipping and shipboard activities will provide information, which is critical to good decision making, and will often clarify the decision to be made. The information generated through risk assessment and management should be properly communicated within the company's shore and shipboard staff to help impacted parties understand the risk factors which influenced by the decisions. This part currently missing from implemented maritime management system and by my project this change is implied to improve the awareness of existing International Safety Management system (ISM) and the add-in voluntarily implemented EMS, QMS and OHMS management systems.

1.2 Background

The safety and environmental protection rules of commercial shipping is regulated by the International Maritime Organisation (IMO) which is a United Nations Agency. There has been an increased interest and concern in IMO for improving safety and environmental protection followed by time to time various severe marine accidents, which have greatly affected the rule-developing process of the IMO. In below Table 1.1 presented the most well known marine accidents for reference and which can easily reviewed for investigation by results published on the internet. The investigation of these major accidents incurred results by which the priority of control for safety operations at sea has been moved on the technical side, condition, and standard of the vessel by targeting 'substandard ships'. Following the above, an intensive plan for ship's safety inspections and extensive surveys by flag, class and port authorities created a loop and gave confidence of safe and secure operations in clean seas. The first step the IMO implemented for establishing a systematic way for improvement of the effectiveness of the maritime management system was the International Safety Management code focused on safety and environmental protection, which

firstly implemented in 1998. Seen in a historical perspective the implementation of ISM, the ship accident rate has been reduced considerably. The average loss rate has gone down from 3 % of the fleet at risk per year compared to roughly less than 0.3 % today but accidents with significant impact continuous. However, despite of the achieved improvement by the implementation of ISM the pace of improvement has slowed down. A possible explanation to the present situation is that the maritime transport has exhausted the present approaches by the implementation of ISM in safety issues and that new ones must be sought. The ability to a systematic decision making process is critical to minimize the risk of poor human and organisational decisions that could have negative effects on operational safety which may eventually lead to a serious accident . Components of a good decision making process include human and organisational factors which have both direct and indirect effects on safety. The presence of uncertainty is well recognised in the decision making process and the systematic risk estimation is often ignored or underestimated when decisions took place. IMO is presently reviewing whether to introduce risk analysis in the maritime sector under the term Formal Safety Assessment (FSA). FSA will involve the basic risk analysis steps and benefit-cost assessment. The intention is that FSA may contribute to identification of risks not covered by the regulations and obtain a set of controls that are more effective. The Formal Safety Assessment (FSA) process proposed during MSC 66 at the IMO and subsequently released as Interim Guidelines (MSC/Circ.829-MCPC/Circ.335) has generated a number of FSA applications over the past few years. Particularly in MSC 73, MSC 74, MSC 75 and MSC 76 and MCS 77 these applications cover a wide area of interests in the marine field, most important one being the FSA Studies on Ship's Safety by various Administrations and Flags and Class societies. In my project, the epistemic approach examined considering the knowledge of parameters and the control of proper implementation of the system. By that way, epistemic uncertainty is critical to allow meaningful decision-making. The proposed approach of my project to involve risk quantification in maritime operational activities and risk management as an add-in management tool to the ISM and other implemented management systems up to now was based on the results emanated by the investigation of several severe accidents and the causes considered created them. Preventive enhancements applied by IMO rule making process every year mainly to the structural strengthens of cargo holds, hatch covers, and towing arrangements producing additional controls to preventive or mitigating measures in accidents scenarios, but these added without the company to shear or understand the risk based decision process and methods for that. Simply determines the cost and schedule for the implementation without the proper awareness and knowledge for the benefits emanated from such decision. So the existing condition in maritime management practically consists of the ISM regarding implied management system on one hand and unified requirements URS for implementing measures which considered that improve effectiveness of preventive or mitigating measures. Finally, the FSA is proposed presently as a tool for rule making in IMO since decision process for new rules and regulations at IMO should be more rational to reduce ad-hoc proposals and implementation. What is missing on that approach is a proactive risk management specific issue approach comprising technical as well as operational and other aspects in specific activity level but also in a corporate level as a risk

based management system either quality, safety or environmental by provision of reliable information on identified hazards, emanated risks and risk control options, their cost and benefits for its application and finally the timely and cost effectively decision making and review. This is the area pertinent to my project.

In 1967 the Torrey Canyon in West Coast of England, in March 1978 the Amoco Cadiz in Northern Coast of France, in September 1980 the Derbyshire in North Pacific, in March 1987 the Herald of Free Enterprise, in March 1989 the Exxon Valdes in West Coast of Alaska, in April 1990 the Scandinavian Star disaster, in January 1993 the Braer, in September 1994 the capsize of the Estonia in the Baltic Sea, in February 1995 the Sea Empress, in January 1998 the Flare, in December 1999 the tanker Erika, in August 2001 the Ferry Express Samina in the island of Paros Greece, and recently the famous Prestige in west coast of Mediterranean sea.

Table 1.1 Major ship related accidents

1.3 Main purpose of my project

Based on the above the most critical probably question always raised when discussing safety and environmental protection initiatives is the criterion of "how safe enough is" the operation or activity under implementation to prevent an incident and consequently to protect or mitigate relative damages. The primary idea is to set key performance indicators for safety, quality and environmental goals of all objectives involved for the maritime activities to prevent damages and losses whatsoever, and to complete fulfilment of the manager's and crew's expectations in terms of perceived risk. Since quantification of achievable goals is not yet definable by an acceptable way the determination of certain levels which could considered acceptable is unfortunately not achievable or agreeable yet therefore a more realistic approach should be defined in terms of set of guidelines that directs the managers and decision makers towards a risk based management system under which reasonably acceptable level of risk could be undertaken. It is obvious that the commercial, safety, quality, environmental and occupational health objectives and priorities should be consistent with the adoption of the available practicable standards by selecting the most cost effective control measures from a set of alternatives in matters concerning maritime occupational health and safety, efficiency in operation and navigation, and prevention and control of marine pollution from ships. Additional consideration should be given to other stakeholders involved in underwriting risk of activities such as insurance P+I, Shippers and Charterers who determine their premium by undertaking their own inspections and audits to secure that employed ships are conforming to acceptable standards. These initiatives have lead to an increased focus on the management system followed by the ship manager in extend of ISM, QMS, EMS and OHSAS and not solely to the inspection of structural condition of the vessel and the crew competence. It is on the other hand a conceptual approach on what is required to operate safely within the frame of company's overall management. According to lessons learnt by the implementation of Safety Management the "Safety culture, top

management responsibility, employee involvement, continuous improvement, long term perspectives, adequate resources, economic health organisation, routines and competence" are some of the critical core elements of the management system which contributes to the generation in the causation chain of an incident and evaluated very seriously by authorities and underwriters. Very little systematic knowledge is available on the relationship between cause of incidents, management core elements, management behaviour, perceived risk and safety performance in commercial shipping. The problem is to find a practical and applicable way to issue procedures and guidance and implement risk tool in day-to-day operations and activities and to establish a risk culture under which shore and ship based personnel will be able to manage and prioritise risks inheriting from their duties. Therefore by knowing the relative importance causation chain and the core elements of the implemented management systems which also analysed and prioritised by the risk management methods will provide a mechanism for predicting the weak risk areas and controlling the most likely scenarios that could result in incidents and top management decision making process which influence middle management and ultimately the safety behaviour onboard the ships.

Initial considerations of my Project
The project had initially considered to:
▪ Establish a common awareness and knowledge about the risk management steps and assessment of safety and environmental impact of ships by the participants shipping companies. ▪ Create a common understanding for the methods, parameters and criteria used by approaches to risk and environmental impact assessment that can be applied to shipping. ▪ Create a preliminary standard database for shipping and shipboard activities, which should be assessed in combination with related hazards by the shipping companies. ▪ Identify all relevant aspects to be considered when assessing risk and impacts from ships. ▪ Collect the different participants viewpoints on assessing risk by likelihood and severity levels of ships ▪ Establish a common knowledge about the elements of Safety, Quality, Environmental and Occupational health Management Systems as per ISM, ISO 9001:2000, ISO 14001: 2004 and OHSAS 18001:2000. ▪ Identify and evaluate relevant safety, quality and environmental elements for management systems.

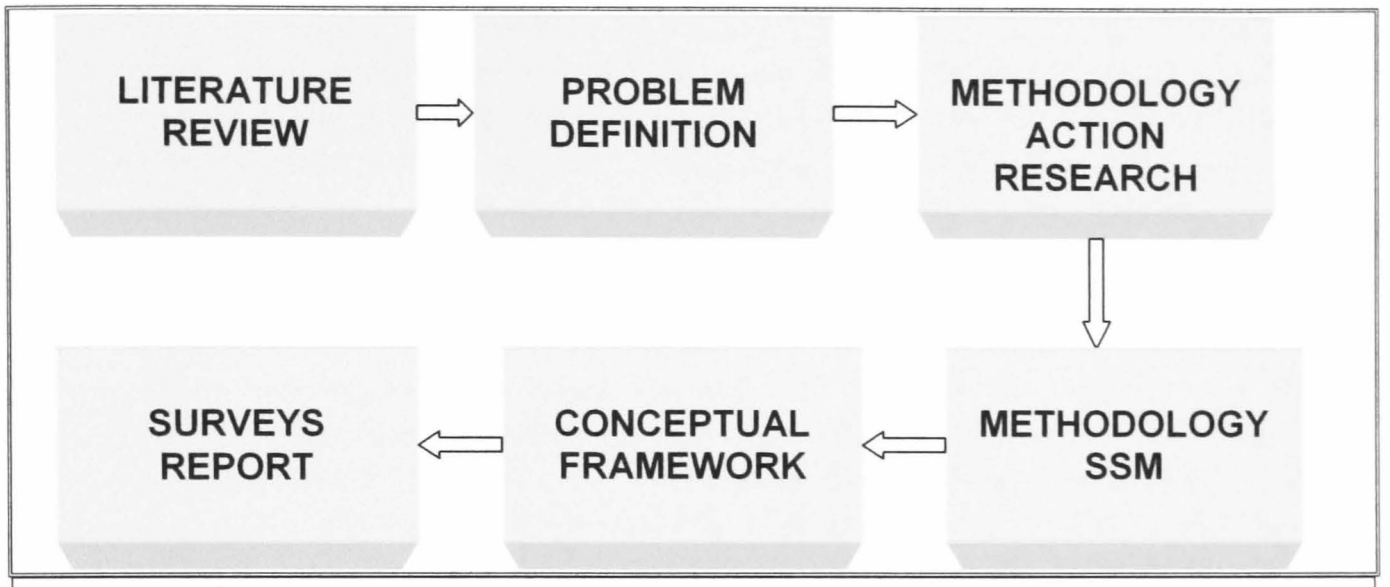
Table 1.2 Initial considerations of my project

1.4 My position and role

My role in this project is to coordinate and administrate my working team in my company in order to analyse and create a risk tool for an integrated management plan of shipping and shipboard activities in which risk analysis and a case study of qualitative analysis will be developed for eight ship's type within the maritime companies participated. Additionally to risk assessment which will be developed in regard of confidence of selected tools, risk management will be verified in the extent of operability and tolerability (ALARP) and causes including human factor will be assessed on top as a cause coefficient depend on the operation. The data base which will be created from the assessment of shipping and shipboard activities for causes and risk index will be further developed by an auditing plan and will give evaluation to the participants companies who will be tested for implementation of a Total Risk Management system accomplished by an integrated auditing system to ensure professional handling of risk weak areas and minimization of consequences for unwanted potential events. I was appointed administrator of this project primarily to my company since my project considered since its concept as an important tool, which will enhance the existing management system substantially and will develop the "safety culture" in "risk culture". As far as regard influence in the maritime industry by implementing my project, management companies will be able to develop and enhance their management system, will reduce substantially both running expenses and premiums underwriting risks, will create an Auditing Collected Data which will be analyzed, evaluated, ranked by relative coefficient and which will be incorporated and combined with shipping and shipboard operations for producing results for preventing incidents and producing predictive models. Finally the project's piece of work will provide a mechanism for ranking, prioritize, predicting and controlling the most likely scenarios that could result in casualties, accidents and incidents. It is also important that my project's results will imply continuous improvement in the identification of preventive and mitigating measures, systems, equipments and communication-information systems, will incur financial growth and will improve fame. Since the beginning, I was aware of potential ethical dilemmas in research, auditing and analysis of the professional practice and work dilemmas within the participated company's and organisations. In the project presented below, I have faced a number of ethical issues associated with operational and contingency preparedness and motivation including no-blame culture, which has largely to do with differences in opinion concerning the usefulness of risk-based approach to the best options for the business future, which I had to manage passionately. Also during audits and analysis, there was much sensitivity associated with this, which I succeeded to manage properly. There were also ethical issues on liabilities concerning SQEOH impacts also Stakeholders priorities, allocated resources emanated by the defined conditions and human behaviour in different appreciation of situations. The major ethical issue that had arisen was a potential conflict between ship-owners and insurance P+I organisations from the results, which could harm in a way of assessment the capacity of a ship manager-owner to manage potential threats for which he is covered accordingly. Therefore, during my surveys and project's research I kept all information in private basis.

1.5 Research Approach

The research approach followed in this study can be summarized in four main categories as shown in Fig 1.1: Methodology.



Methodology

1. A literature review which includes the in depth examination of the risk management systems in maritime and other industries, the risk assessment methods and techniques which are implemented in management systems and which are also suitable in Maritime Management, the evaluation of risk management elements in general. The analysis of common core elements of implemented management systems as an integrated management and several risk management practices in order to be able to make a detailed problem definition and to define an overall methodology.
2. My research is employing action research for the retrieving information regarding awareness and implementation of risk management in day-to-day operation of shipping activities. Then a change in culture for implemented management systems attempted by implementing risk management approach in existing management systems. This achieved by the case studies with which risk estimation concerned in combination with confidence assessment and evaluation of results occurred. The participants involved are 50 maritime companies in informative questionnaire and 46 companies in case studies of various ships' types.

The research of this area is qualitative and participative. The problem with which the research starts and aims to take action to improve the situation is:

▪ Can Risk management be implemented in Maritime Companies as a proactive risk based management approach comprising technical as well as operational aspects in specific activity level but also in a corporate level? ▪ Can this risk management system combined with existing management systems in the basis of common core elements. ▪ Can the maritime companies rank by a systematic auditing system their management systems basis on risk estimation and prioritization of control measures in order to improve their effectiveness and reduce the probability and severity of a potential unwanted event. ▪ Finally, what is the gap analysis between the existing situation and the actual one and what is the actual time schedule for effective implementation. Based on the above questions I have developed the conceptual design of the surveys for the risk management system, formulations for each survey, determined the core elements to be used, the standards requirements, the conceptual design of the database, and conceptual design of the multivariable program.
3. For the last question raised, I have created an auditing plan which I considered that follows SSM defining the problem in a different conceptual framework since risk and safety culture is strongly involved justifying the mission of continuous improvement. ▪ By identification and implementation of my project the change in management of shipping and shipboard activities will become risk based with proper identification and awareness, setting priorities and proper distribution of resources by which the performance of safety, quality and environmental protection will be improved substantially by relative reducing cause's probability of an unwanted incident. The testing and evaluation and finally the measurement of improved and achieved risk preventive or mitigate performance by the implementation of integrated risk auditing system is determining the impact of the change made on the original problem proved by the achievable results of my project. By programming the multivariable system elements according to the conceptual design, coding of the consequence model, setting up the data, creating tables and establishing relationships among them the trend and confidence implied for the decision making process.
4. Finally documentation of all the surveys studied to produce the final report of the project.

Table 1.3 Methodology

1.6 Report Organization

This report consists of seven chapters, which presented in this research.

Chapter 1 provides a brief introduction and background of the project including the initial problem definition and objectives of the study. It is also included the main purpose of the project I have undertaken and my position and role in this project including an overview of the general management system dealt in the project. An analysis of the research approaches presented in this chapter and the main categories presented with methodology followed by the project. Finally the presentation of this report organisation presented.

Chapter 2 summarizes a literature review and discusses a general overview regarding risk and regulations of existing risk management systems, the relation between risk and decision-making process including presentation of risk, causation chain and shipping and shipboard activities. The stakeholders having direct interest are presented and the conceptual framework of my project established. The work based learning features and applications presented as well as the significance of the work based project. Finally the applications and impact of my project presented for the risk management systems in maritime management and especially to the integrated management systems.

Chapter 3 presenting the maritime risk management framework and summarizes the review of the existing maritime risk management system practices and techniques, namely: Hazard Identification, Risk Analysis, Risk Management and Risk Auditing. This Chapter analyzes the different aspects of these elements including shipping activities, models and formulations, data requirements, ease in implementation, user friendliness etc. Risk management methodologies used in maritime management systems are outlined including decision-making process, and benefits of implementing integrated management systems are emphasized. Presentation of qualitative and quantitative approaches also presented as a methodology tool for the case studies followed the research approach and the establishment of probability and severity scales presented in the form requested by the questionnaire. Frequency and consequences assessment methods outlined as a quantitative approach for the research. Finally maritime risk management implementation presented with relative strengths and weaknesses of the project.

Chapter 4 discusses the project research families' approaches and techniques as well as the methodology and the models of the surveys of the integrated auditing management system and the formulations for these models. There are two main models in the system: the specific issue risk management model, and the corporate risk management model. Each of these models has several sub modules, which are used and evaluated with a different set of criteria resulting analysis and setup of database scores. This Chapter discusses also how the research aims and objectives will be accomplished how the specific issue risk management and corporate risk management models and their related sub-modules are formulated in this study. The formulation for the common core elements of risk ranking that is used to evaluate maritime companies and other research issues such as validity, feasibility and ethical is provided in this Chapter.

Chapter 5 describes the project's activity and the details of thereof the surveys consisted of informative questionnaire, case studies and auditing surveys including the design of a database, the main system structural design, the data tables to be used in the system, the inter-relationships of these data tables and the data items to be included in these data tables.

Chapter 6 describes the project's findings and results of the surveys, the software developed in this study for the statistical analysis and development of a multivariable relative weight decision tool and its results. It provides statistical analysis for assessing risk contributors in management systems and risk prediction models.

Chapter 7 is the concluding chapter including conclusions and recommendations and discusses for the planning and strategy of implementation and the future research that can be performed on this subject.

Bibliography follows the chapters with reference to the publications from which the background and literature review retrieved in a proper format.

Appendices presented also with all information regarding databases and results with relative diagrams and presentation tools.

CHAPTER TWO: CONCEPTUAL FRAMEWORK

2.1 Nature of risk

There is inherent risk in managing the shipping and shipboard activities and operations in marine transportation industry pertinent to safety, quality, environmental protection and occupational health. Decisions made everyday are based upon risk. Usually, decisions are intuitive in nature and rooted in common sense. The decision, for example, of whether or not to get a marine vessel underway entails a risk assessment of forecasted sea conditions. If significant tide variations may be encountered, tides should be considered in an effort to minimize the risk of grounding. To manage such a risk, the operator might choose to depart earlier, load less cargo, or delay departure, until more favourable tide conditions exists. Everyday decisions, like those made based on the tide before sailing and a vessel's draft before mooring or during loading, do not usually apply the use of a formal risk assessment methods or concerns. Even in most complicate decisions and cases, a risk assessment is missing that details anticipated hazards and examines the likelihood and consequences of those hazards, and a risk management plan that specifies additional safety measures to mitigate those hazards, could organize and clarify the important issues of that decision. There are only few things we could develop in estimating and analysing aleatory risk in Maritime industry and a realistic approach should always contribute to a major incident both the aleatory and epistemic risk contribution. In this project the awareness of the driving system is focused and the activities which contribute to risk factors. It means that in our case, the system itself analysed and developed by a risk filter and approach, which has, mainly epistemic view participated. Such activities which influence epistemic risk in a vessel are the shipboard activities including and not limited to operation, navigation, cargo loading-discharging, ballasting-deballasting, mooring-unmooring, propulsion engineering, arrivals and departures which take place across in a large geographical area and are time-critical by containing elements of associated risk (e.g. congested waters, reduced visibility, slippery surfaces, high temperatures, time-critical schedules). Additionally the technological properties of used machinery and equipments in the vessel's systems-machinery systems, navigational and cargo equipment, software, control systems, mooring lines, communication and identification equipments etc.—are critical by containing potential hazards from improper operation and malfunction risk. Finally, cultures for safety and prevention in marine transportation can establish an over enthusiastic, self-confidence, which will reduce interest in training, drills, and routine practices, resulted a potential risk of a major incident by extending the risk tolerance of the system. There is not yet established a universally accepted definition of risk and hazard confusing users in awareness and communication of risk issues, but the one commonly applied and regarded as authoritative in most industrial contexts is: "A combination of the probability and frequency of the occurrence of a defined hazard and the magnitude of the consequences of this occurrence."(ISO 8402:1995 / BS 4778). IMO in the Formal Safety assessment guidance defines risk as: "Risk is the combination of the frequency and the severity of the consequence." (MSC Circ 1023/MEPC Circ

392). In other words, risk has two components: likelihood, frequency or probability of occurrence and severity of the consequences. In order to avoid confusion the definition of hazard presented here with relative examples. "A Hazard is a substance, situation or practice that has the potential to cause harm". In order to create risk a hazard should be involved in an activity and then in order to manage same proper actions should be considered for the identification of hazards, the assessment of the risks associated with those hazards, the application of controls to reduce the risks that are deemed intolerable, the monitoring of the effectiveness of the controls and finally by reviewing this iterative process could secure continuous improvement. The controls are important in the management of risk. Existing control are applied either to reduce the likelihood of occurrence of an adverse event, or to reduce the severity of the consequences during the routine activity. Additional control options are considered in case a risk resulted in an activity is intolerable and specifically in non-routine or in an emergency condition. The risks we are concerned are those that are reasonably foreseeable within the shipping and shipboard activities and related to the health and safety of all those who are directly or indirectly involved in the activity, or who may be otherwise affected, the property of the company and others, the environmental protection and the quality of the provided services. The risk factors introduced in shipboard activities are clearly presented in my project and related to the maritime transportation system but reflect also to the hazards, activities and risks of a single activity model without interaction of other activities. Risk relating a top event during an activity in the management system can be prevented or migrated, particularly when additional risk preventive or mitigation measures are timely introduced, but when interaction exists things are most complicated in which case when one risk problem may be solved with the introduction of a risk preventive or mitigation measure and at the same time another emanated new risk problem can emerge as a result of the introduction of that risk preventive or mitigation measures. In addition, escalating factors in the system may also have long incubation periods, and these risk factors may lie inactive for long periods, until catalyzed by the right combination of triggering events. That is why in my project each activity analysed as a combination of elements related to safety, quality, environmental protection and occupational health in order easily to combine each other similar properties and creating proportional results. Maritime management is, by definition, a large-scale system at sea with limited organisation ashore. Traditional organization with limited shore based personnel created redundancy in the system, training, checks and maintenance onboard. This condition can be developed by the size of the fleet with relatively bigger and more qualified organisation as well as by improving the scope of the management system itself by introduction of risk management approach. Thus, by identifying and assessing risks in combination with the role of human and organizational competence in the system it is feasible, although important to develop a suitable management system under which personnel ashore and onboard could control human and organizational error which is often quoted as being responsible for more than 80% of accidents in marine transportation (crew negligence).

2.2 Regulatory risk

The International Safety Management Code (ISM) implemented firstly in 1998 to the vast majority of ships is a compulsory management system for proper safety ship management of all types' ships. In the ISM Code within the stated objectives set out and particularly in paragraph 1.2.2.2 of the ISM Code states, "Safety management objectives of the company should "establish safeguards against all identified risks". The ISO 9001:2000 is a Quality Management System amending ISO 9001: 1996 which is an International standard determining the requirements for a voluntary Quality Management system which is also implemented in Maritime management. There are several clauses related to risk management such as clause 5.2 "Customer focus", clause 7.2.1 "Determination of requirements related to the product", clause 7.2.2 "review of requirements related to the product". In maritime activities product should considered either the ship management services or the contracts for ship's transport employment and respectively ship-owners and charterers considered the clients. The Environmental Management System (EMS) is also a voluntary program that results the integrated management of environmental practices and prevention of non-compliance with environmental regulations. The ISO 14001:1996 which amended by the new release ISO 14001:2004 is an environmental management standard designed to provide an internationally recognised framework for environmental management, measurement, evaluation and auditing. The ISO 14001:1996 establishes three requirements with significant relationships to risk assessment and risk management. Clause 4.3.1: An organization must develop and maintain a procedure to identify the "environmental aspects" of its operations. This includes its activities, products and services, and those of other organizations over which it can be expected to have influence. The organization must determine those environmental aspects, which have or can have "significant" impacts on the environment. The organization is also to ensure that the aspects related to these significant impacts are considered in setting its environmental objectives. Risk analysis techniques can form an important part of the procedure used to identify and evaluate a company's environmental aspects, thereby helping to address one of the grey areas in ISO 14001. Clause 4.3.3: An organization must develop and work towards environmental objectives and targets, as relevant to each function and level within the organization. The quantitative results of risk analysis can help to establish objectives and measurable targets, thereby helping to address another of the grey areas in ISO 14001 in which key performance indicators should defined. Clause 4.6: The organization must perform a periodic management review of its EMS, to address the possible need for changes to policy, objectives and other elements of the EMS. Having concrete information to consider, such as that provided by risk-analysis, greatly assists the management review function. OHSAS 18001:1999 is not wet adopted as an International Standard but widely used as specification gives requirements for an occupational health and safety management system. This is also a voluntary management system, which enables an organisation to control its OH&S risks and improve its performance. The OHSAS 18001:1999 establishes clear requirements for hazard identification, risk assessment and risk control in its clause 4.3.1 under which the organisation shall establish and maintain procedures for the ongoing identification of hazards,

the assessment of risks and control measures during routine and non routine activities for all personnel having access to ship. In order to implement risk management requirements defined by the above-mentioned standard clauses, many approaches developed without yet to have a prescriptive framework to a risk based approach. Traditionally, the maritime industry has been reactive in its development of rules and standards for ship safety. Formal Safety Assessment (FSA) is a rational and systematic process for the proactive management of safety based on principles of hazard identification, risk analysis and cost-effectiveness evaluation of the efforts in controlling the risks. IASMAR emanated risk management tool in addition to FSA can be used as a tool to help in the development additionally of an integrated risk based management system by analysing an existing set of standards, and thus to achieve a balance between various technical and operational issues, including human element and costs. My project contributes to the proper implementation of FSA since the steps described are analysed and systematically embodied in the risk based management system developed by IASMAR core elements.

2.3 Risk and decision-making

The decision making process is intended to assist decision makers to acquire, analyze and evaluate the information needed to make decisions in areas affected by risk. Since activities are correlated with the implemented management system whether ISM, QMS, EMS or OHMS is and also related to the decisions needed to be taken for execution of those, decision making is directly related with management systems and followed their principles and procedures. It is also the combination of the activity with hazard, which resulted to threat and top event, and the decision with the risk control options selected based on their effectiveness and cost benefit to prevent top event or to mitigate consequences. So the relation between decisions making for risk control options(which could be technical, procedural or human) and assessment of the tolerability of risk and its acceptability, proves the criticality of the decision making process in the risk based management system implementation. The decision making process is designed to help the ship managers, to arrive at informed judgements as to the significance of a risk, what level of the risk is deemed acceptable, what level of control might be appropriate, and how to communicate about the risk with stakeholders. This is the stage where the company reviews all the information gathered for selecting the most appropriate option for managing the risks. This is something very important which mostly overlooked or underestimated by the management mainly due to time and resource constraints. It has been noticed through the execution of my project by the participants that accidents incurred mainly by incidents for which improper or poor decision have been taken due to various reasons such as poor communication, time limits, poor market, difficult trading areas, lack of training and lack of understanding requirements. This means that accidents or significant incidents created in a second stage emanated by poor decisions solving the incident in the first stage. A Risk-based decision making process involves a series of basic steps. It can add value to almost any situation, especially when the possibility exists for serious or catastrophic outcomes. The steps can be used at different levels of detail and with varying degrees of formality, depending on the situation. The key to using

the process is in completing each step in the most simple, practical way to provide the information the decision maker needs. Some situations are so complex that detailed risk assessments are needed, but most can be addressed with more simple and practical logical tree risk evaluation. The key to success depends to a large extent on ensuring as far as possible that interested parties are aware with the process for reaching decisions and that information received are as possible reliable and accurate. Most decisions require information not only about risk, but also about other things as well such as the way of the uncertainty has been addressed, the assumptions made; and how other relevant factors have been integrated in the decision-making process. Meeting these conditions is not always easy to achieve, particularly when interested parties have opposing opinions based on differences in fundamental values or confine themselves to a single specific issue. Nevertheless, in order to manage the process we should find out and focus on the uncertainties that matter and define why a particular method will be chosen, in preference to others, for the estimation of the risks. It has been concluded by the participants of my project's research that there are not only few geographical areas, countries and ports that there is an ethical preference of producing cargo shortages in huge scale resulting a substantial risk exposure to the managers and ships beside this is not the actual condition. Even if this condition considered unacceptable for the risk and exposure involves decisions a broadly positive decision adopted by the common practice but certainly overlooking of additional control measures could lead to a catastrophic results as far as regard property. So some times in order to take account of uncertainty and the need to adopt a precautionary approach in doubtful conditions might require to focus more on the consequences of harm occurring from a hazard than on the likelihood that the hazard will be realised. It means that every time vessel will call such place risk calculation is irrelative of the likelihood but mainly calculated by the severity of the consequences. When we have reached a decision on the degree to which a risk should be controlled, we have to decide how the decision can be implemented in practice using the regulatory tools of class, flag, or PSC at our disposal. Regardless of how formally is addressed risk-based decision making or the specific tools used, risk-based decision making is made up of seven major components and is considered critical since creating a decision structure for understanding and defining the decision that must be made. These components of risk-based decision-making are strongly related to my research for the identification of core elements and for that deserve more discussion. It is important at that stage to identify the specific activity which contributing to threat in combination with hazard, to identify also the extension of the threat in safety, quality, environmental or occupational health dimensions and then to perform the following tasks that must be performed to accomplish decision making.

Firstly, by recognizing if a ***decision*** and ***what decision*** needs to be made. The important is how effectively will be distributed the available limited resources, and how managers can understand organizational goals and how well these goals are being met with the decisions have taken. Choices about what activities to perform or allow, and how to perform or regulate them, are common during risk-based decision making

Secondly, by determining who is needed to be involved in the decision since most decisions affect more than one stakeholders group. These potentially affected groups are called ***stakeholders***. Stakeholder input into the decision-making process is crucial for reaching the best decision and improving effectiveness of risk control options.

Thirdly, by identifying the options of alternative ***risk scenarios*** and preventive or mitigating measures available to the decision maker in the base of effectiveness and cost benefit analysis. A range of alternative risk control options usually exists for most decisions, and many of these options come from stakeholders. Focusing in this way makes the decision-making process more efficient.

Fourthly, by ***analysing the risk factors***, this will probably influence the decisions during the ongoing risk assessment process. Few decisions are based on only one risk factor. Most require the decision maker to consider many factors, including costs, schedules, risks, etc., at the same time. These factors must be identified by stakeholders so that the factors can be considered in the decision-making process.

Fifthly by ***evaluating information*** about the factors that influence stakeholders. Information must be collected about the factors used by decision makers to make their choices. Because risk affects most decisions, risk assessment is often used at this point.

Sixthly by reaching ***agreed-upon decisions*** based on the information. With information available regarding the various decision factors, the decision makers can make informed decisions.

Seventhly by ***communicating*** and implementing decisions. Once decisions are made, they must be communicated to everyone affected by the change. The actions related to the decision must then be implemented. The information collected during communication is not necessary to be highly detailed or precise. The main purpose of using risk and emergency preparedness analyses is to formulate a decision-making basis that may contribute to selecting safety wise optimum solutions and risk reducing measures on a sound technical and organisational basis.

2.4 Shipping and Shipboard activities

Before any risk assessment carried out, it is important to identify and list all shipping and shipboard activities, which during their action in combination with associated hazards, could inherent a threat to health, safety, environment and property. Despite the level of risk involved from an initial assessment, it is important to list all shipping and shipboard activities in relation with ship's type by using the following format, which presented as the Activities Framework.

Area of activity: Should consider the area in which the activity is taking place. Shipping activities area considered; Area of Shipping activity: Chartering, Marine Operations, Technical, Purchasing, Personnel, Insurance, Financial ECT, as per company's organisational structure.
Area of Shipboard activity: Deck, Engine, Accommodation, Cargo ECT, as per ship's organisational structure.
Type of the activity: Should consider the type of the activity, type of action or operation by undergoing of which a threat is considered to result an unwanted event.
Type of Shipping activity: Contract, Ship management Agreement, Charter party, Shipyard agreement, Maintenance contract, Technical consultancy, Source of supply, Transport agreement, Manning Agreement, Financial agreement ECT, as per company's specific activities.
Area of Shipboard activity: Routines, Mooring, Navigation, Maintenance, ECT, as per ship's activities.
Functioning of the activity: Should consider the specific operation or action of an activity carried out by undergoing of which a threat is considered to result an unwanted event.
Operation of shipping activity: Indicative attach the following presented in my survey such as Invoices Non Payment, Invoices delay of payment, Insolvency of Charterer, Arbitrarily deductions, Renegotiation of hire, , ECT, as per company's specific activities.
Functioning of Shipboard activity: chemicals handling treatment, heavy lift equipments, hot work control, manual cleaning ECT, as per ship's specific activities.
Within the shipping industry, a number of influences with associated elements escalate the risk cause of an accident. These influences and elements are:
Market influence with associated extensions in political influence, societal influence, regulatory influence and generally the public concern should consider as elements.
Management influence with associated policy, objectives and programmes in safety, quality, environmental protection, occupational health, ship design, and management of change influencing and motive the activities. In addition, management also influence in operational issues as the shipboard level with the elements as factors could influence an accident such as shipboard procedures competence, human behaviour, workplace, communications, operational instructions and PPE and operational equipment influencing and motive the activities. Poor market and management with high public concern and increased accident liability combination, which frequently existed in maritime industry, could lead decision makers to undergo activities in doubtful "fearing responsibilities" way by which inheritably hazards associated gained time needed to escalated and transform a top event to severe. Activities can be influenced by market and management relatively to the area, like same activity in different area, relatively to type and to operation and direction of influence is like a loop by mostly starting from the market (buying initiative, cost benefit initiative, resources) to management and then to shipping and shipboard activities from the top down with the upper of any two influences determining how the shipping and shipboard activities functions The operation of the shipping and shipboard activities in combination with the associated hazards is considered a potential threat which

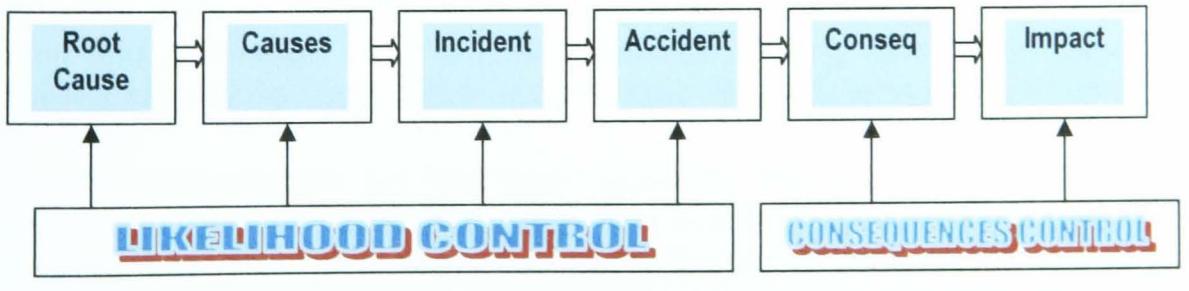
under certain circumstances could lead to the potential top event. The combination of activity with hazard is representing the causation chain for which in shipping and shipboard activities is derived in the direct causes responsible for the accident counted and defined as unsafe acts and unsafe conditions and the indirect causes counted responsible for the accident such as human factors and technical factors counted although they are manifested at the operational level. In my project and Chapter 3 I have extensively discuss the identification of the direct and indirect causes.
An inventory of shipping and shipboard activities presented and used trough out the Case studies presented in the Appendices and categorized by the area of operation.

CAUSATION CHAIN			
UA	Unsafe act	UC	Unsafe condition
UA 01	Unauthorized entry	UC 01	Inadequate safeguards
UA 02	Unauthorized operation	UC 02	Inadequate/Improper PPE
UA 03	Removing safety devices	UC 03	Defective tools
UA 04	Using defective equipment	UC 04	Defective materials
UA 05	Improper use of equipment	UC 05	Incorrect loading
UA 06	Not using Personal PE	UC 06	Workspace restrictions
UA 07	Improper lifting	UC 07	Hazardous conditions
UA 08	Improper contracting	UC 08	Corrosion weakening
UA 09	Servicing during operation	UC 09	Engine overloading
UA 10	Horseplay	UC 10	Design life exceeded
UA 11	Influence of alcohol/drugs	UC 11	Noise
UA 12	Entering in enclosed space	UC 12	Temperature differences
UA 13	Improper monitoring	UC 13	Inadequate lighting
UA 14	Improper loading/discharge	UC 14	Inadequate ventilation
UA 15	Improper positioning	UC 15	Overpressure of tanks
UA 16	Improper route planning	UC 16	Poor housekeeping
UA 17	Traffic rules violation	UC 17	Berths not ready
UA 18	Deviation from course	UC 18	Uncharted submerged pieces
UA 19	Hot works in gas area	UC 19	Weather conditions
UA 20	Spark generation	UC 20	Ship conditions(trim ect)
UA 21	Lack of Maintenance	UC 21	Wet/ slippery deck
UA 22	Improper supervision	UC 22	Traffic
UA 23	Improper handling	UC 23	Gas releases
UA 24	Improper operation	UC 24	Fires
UA 25	Making barriers inoperable	UC 25	Dropped objects
UA 26	Improper heating	UC 26	Flammable materials
UA 27	Improper connection	UC 27	Inadequate escape route
UA 28	Improper filling	UC 28	Living conditions
UA 29	Improper care	UC 29	Waste disposal
UA 30	Improper repairs	UC 30	Unreliable Charterer
UA 31	Release of sludge / oil	UC 31	Floating objects
DIRECT CAUSES			
CAUSATION CHAIN			

Table 2.1 Causation chain direct causes

CAUSATION CHAIN			
HF	**Human factors**	**WF**	**Technical Factors**
HF 01	Trained personnel	WF 01	Lack of working standards
HF 02	Communication problems	WF 02	Inadequate purchasing
HF 03	Inhalation of harmful substances	WF 03	Inadequate maintenance
HF 04	Skin contact with harmful substances	WF 04	Inadequate tools
HF 05	Eye contact with harmful substances	WF 05	Inadequate equipment
HF 06	Mentally inadequate	WF 06	Engineering failures
HF 07	Lack of knowledge	WF 07	Inoperable control
HF 08	Lack of skills	WF 08	Heavy objects
HF 09	Lack of understanding	WF 09	Unsecured objects
HF 10	Stress	WF 10	Leakages
HF 11	Improper motivation	WF 11	Inadequate engineering
HF 12	Fatigue	WF 12	Equipment reliability
HF 13	Oversight	WF 13	Inadequate air supply
HF 14	Vertigo	WF 14	Inadequate lubrication
HF 15	Lack of following procedures	WF 15	Communication failure
HF 16	Lack of following instructions	WF 16	Improper stores
HF 17	Complacent	WF 17	Lack of controls
HF 18	Untrained officers	WF 18	Schedule of maintenance
HF 19	Lack of leadership	WF 19	Lack of working orders
HF 20	Warning of personnel	WF 20	Improper valve operation
HF 21	Economic pressure to hurry	WF 21	Not original spares
HF 22	Neglecting traffic conditions	WF 22	Defective sounding pipes
HF 23	Lack of emergency preparedness	WF 23	Beaten tools
HF 24	Knowledge of inherent dangers	WF 24	Worn out equipment
HF 26	Overreacting	WF 26	Worn out hoses
HF 27	Excess of self confidence	WF 27	Rotten tools
HF 28	Lack of timely payment of wages	WF 28	Start operation failure
HF 29	Family problems	WF 29	Old falls or gripes
HF 30	invalidism	WF 30	Proper production neutral gas
HF 31	Low scale wages	WF 31	Defective machinery
HF 32	Lack of timely payment of wages	WF 32	Inoperable machinery
INDIRECT CAUSES			

Table 2.1 Causation chain Indirect causes



2.5 Stakeholders

Stakeholders may include a variety of individuals or organizations related to the shipping activities and their environment. Some may be internal and others external to the maritime industry. A stakeholder defined as a party investing risk in shipping activities and operations. In many cases, the stakeholder who imposes certain risks is not the same stakeholder who carries these risks. In order to complete the list of possible stakeholders, reference must be made to the context and possible consequences of the decision to further identify stakeholders that could be involved. The list of the stakeholders should include all of those persons and/or organizations who are affected, or might believe they could be affected, by the ship management decision and/or shipping activity; they have the right, or might believe they have the right, to participate in the decision making process; that they can affect the decisions; or could influence those who are affected or might perceive themselves to be affected by the ship management decision and/or shipping and shipboard activities. Dialogue with identified stakeholders can aid in identifying new ones. However, the list can eventually be reduced based on a subsequent evaluation of stakeholder's needs.
Data and information are very important when decision-makers need to make sound decisions. Sometimes data and information are not readily available, especially when addressing a stakeholder's perception or acceptance of a risk or the way a risk is handled so communication is an essential tool to fill this void, and to obtain information that is accurate, complete, timely and relevant.
Effective communication between ship managers and stakeholders is always fundamental to the achievement of the goals of risk management. An important objective is to obtain information and develop a thorough understanding of the needs of the internal and external stakeholders. On the other hand, the communication process must not be allowed to become so complex that it impedes the timely completion of the overall risk management process. The exchange of information with stakeholders can assist the decision-maker by providing greater understanding of the issues and in identifying possible options. It can also help the decision-maker to more accurately assessment of the impact of decisions on the needs, issues and concerns of stakeholders also the acceptability and the emanated liability. Stakeholder profiles can help to thoroughly inventory stakeholder's needs, issues and concerns and should be developed whenever a good understanding of stakeholder motivations may be critical to the successful resolution of an issue. Stakeholder profiles are also an important starting point for the development of communication and consultation plans and strategies for the implementation of any decisions. The stakeholder analysis should be reviewed to ensure that all applicable stakeholders have been identified.
Once the stakeholder list has been updated, the stakeholders should be listed into groups for communication purposes. Within each group should be assessed which stakeholder can have the most impact on the implementation of the shipboard activity. It is important to understand stakeholder's perceptions, both negative and positive, so that the reasons for those perceptions can be addressed. Below table provides a general list (no limit) of potential stakeholders for the shipping activities.

· Owner	· Passenger
· Charterer	· Crew
· Cargo owner	· Security organisations
· Operator	· Industry associations
· Local Coast Guard	· Local port authorities
· Local pilots	· Environmental organizations
· Local towing companies	· Federal government
· Other vessel	· Shore side management
· State government agencies	· Flag State
· Insurer	· Classification

Table 2.2 Stakeholders

2.6 Conceptual framework of the project

There are very limited attempts have been made to explore systematically the theoretical bases of different stages of risk perception within a ship management system and how these stages are related to each other. The role of risk management in structuring and quantifying uncertainty in shipboard operations and shipping activities on one hand and supporting shipping companies in decision-making through the implemented management system. Additional interest emanated by liabilities related to shipping activities and shipboard operations dramatically increased and compulsory implied by nations' rules and laws. The probability and severity of a ship related incident producing the risk level according to which additional control measures deemed necessary to reduce it to the ALARP region. An approach to evaluate the tolerability and acceptability in risk management, or risk assessment approach of specific activity is the review of management system and shipboard activities as far as regard consideration of risk performance and success. Risk assessment has received a status in the maritime industry as Formal Safety Assessment (FSA) and is mainly for the rule making process. This does not mean that risk assessment is procedurally similar in the different application of maritime activities and operations. In fact, risk assessment varies with respect to the use of experience data, expert judgement, risk modelling, decision rules and criteria. Furthermore, even within organisation, risk assessments differ at company or activity level and combining risk comparison and risk communication of risk assessment results. This project aims at illustrating the basic theoretical foundations for the risk management approach and review of the implemented management systems pertinent to safety, environmental protection and occupational health based on decision analysis in the maritime management. In this project, the management system monitored for the fulfilment of basic risk management criteria mostly emanated from ISM and ISO implemented standards. The specific activity shipboard operations follow mainly the formal safety assessment process with additional elements of risk management and decision-making process. The approach of an integrated auditing system for maritime ship management examined in relation with management system's international standards ISO 9001: 2000, ISO 14001:1996, OHSAS 18001:1999 and the international safety

management code ISM matrix of weighted core elements. The below seven segments approach was chosen as a theoretical basis for my project's risk management approach.

First companies in marine industry are increasingly concerned about achieving and demonstrating sound and efficient safety, quality, environmental protection and occupational health performance by implementing a total management system.

Second, there are International standards dealing with requirements of the marine industry. The ISM Code focuses on the safe management and operation of ships and pollution prevention. ISO 9001 is designed to ensure that customer requirements for quality are met. ISO 14001 provides the elements of an effective environmental management system. OHSAS 18001 is not yet an International standard but could be implemented as the other standards and designed to provide the elements of controlling Occupational health and safety and improve its performance. These four standards are complementary in nature and should be integrated in one ship management system so as ISM, QMS, EMS and OHSAS integrated in one system as Integrated Ship management system (ISMS).

Third, there is a risk structured and systematic methodology, which promoted in the evaluation of new regulations in the maritime safety. Since risk assessment need is defined in each mentioned management system by relative clauses for continuous improvement and decision making process this considered to be combined by Formal Safety Assessment (FSA) technique which guidelines has been well established and proposed by IMO and by theoretical foundations in the implementation of the rule making process.

Fourth by conducting my research the vast majority of Ship management activities (SMA) and operations identified and standardized and produced a dynamic list for which ISM and ISO international standard requirements defined to ensure proper implementation.

Fifth by implementing my case studies to the ship management activities (SMA) and operations, these have been properly risk assessed and ranked and additional control measures examined for tolerability and acceptability of risk level.

Sixth, the risk approach embodied in the management system by providing certain recommendation in the management system elements emanated for the research results will provide proper guidance risk assessment in each element implementation providing a Total Risk management system (RMS).

Seventh by conducting my audit survey to the elements of the Risk Management system there is a systematic way to assess and weight its performance and efficiency and estimate areas, which needed improvement or additional measures to lower level of risk in the ALARP region. At this point, it is helpful to point out the distinctive relationship between specific activity risk management (SARM) and corporate risk management (CORM). The SARM risk management process is suited to decisions and subsequent actions regarding specific operation and activity risk issues. Corporate risk management sets the framework of the Total Ship management system (TSMS) for the elements

applied in which the overall context of the corporate objectives programmes and priorities are monitored and evaluated for the ongoing performance both of the ability to make risk-based decisions and the success of their results. Within my project's activity it was also emphasized the need for those participated and are responsible for risks in an organization (senior management, DPA) to know pertinent information about the risk characteristics, and for senior management to have the awareness and knowledge of how to introduce risk management to their companies. The capability emanated by my project should be at the level of understanding to assess the risk, control the risk and monitor the risk. A challenge for my project is to develop more harmonised practices based on the International standards for conducting risk review audits where issues related to establishing confidence in risk assessment results, which are systematically or generically addressed. This entails a conceptual framework for addressing determinants of confidence of the decision-makers with respect to risk assessment results and improves weak points and areas, which seem to be neglected or uncared for hazardous occurrences. This has implications at the level of auditing collection data acquisition, elicitation of management's judgement and risk modelling approaches applied during risk assessments.

2.7 Work based learning

My review of previous work based learning provided a background to my acquisition of knowledge and experience in safety, quality, environmental and occupational health management. My learning review draws upon 22 years of professional experience, with special emphasis on skills, knowledge and capabilities developed throughout my carrier to date. It is also highlights the acquired special knowledge within my professional contexts of production and maritime management. My experience in technical and administrative positions in Maritime management companies gave me the opportunity to deal / handle and solve a wide variety of cases and aspects of safety and risk management, which have provided inspiration for the proposed approach of the research project. The risk-based decision making management was basically the process of my administration for navigating to date my Department, Division and Company along the desired course. As such, it was a problem-solving development process it gave me the opportunity of knowledge to identify and experience the technical parameters and the commercial conditions of safety and quality, which has affected to deviations from the desired course, or to signal that the system is approaching the edges of tolerable safety and quality levels. The combination of knowledge and experience that I have gathered to date gives me the capacity to enhance the risk based safety management system by an appropriate integrated auditing system proposed in my project which monitors, controls, reviews, secures and develops it self by loop amending the sequence of actions during a potential hazardous accident or incident. The actual implementation of International Safety and Quality Management in various types of ships and relative certification confirmed my deep theoretical knowledge of Maritime management and Engineering. My knowledge also evidenced in various internal end external audits I have been asked to carry out and complete ashore and onboard the ships with various colleagues and external auditors from all over the world. The ways I have worked on action and in action, and the ways of

understanding personal and organisational development in problem definition and management integrated through action research and organisational learning and provided me with the capacity and initiative geared towards, ensuring that I have the knowledge required and also utilise most of the knowledge resources I have. Within also the period of my project I was attended main training courses for auditor / Lead auditor skills for ISO 9001:2000, EMS ISO 14001:1996, ISO 14001:2004, OHSAS 18001:1999, Risk Management, Incident investigation which I completed successfully.

2.8 Significance of the work based project

My research project was interesting since the beginning in many respects. By the achievable results of my research project presented the Ship management companies will succeed to establish a Risk Management system accomplished by an integrated audit system under which all risks are identified and evaluated for each one of shipping and shipboard activities and can easily quantified and compared to pre assigned values in order to define weak areas related to increased risk exposure. The data collected and analysed confirmed the participant's perception on importance of relation with relative risk index correlation to causation chain. By that achievement which currently missing by ship management system an optimal allocation of resources and selection of suitable controls will put in place to manage the identified risks and the links between risk controls, operating procedures, and the management activities will be properly combined in an efficient and cost effective manner. My project will assist the shipping industry to achieve a major organisational change and accomplish its safety and quality objectives by bringing a systematic, disciplined approach to evaluate and improve the effectiveness of risk management, control, and operational processes. By my project "at risk" management areas can now be easily identified and should be watched more closely particularly to avoid implication during multiple port state and class enhanced surveys. This will save a lot in time and cost as well as reputation and easily access in ports where banned procedures have been established. A specific activity inventory will be created based on my research amended for the specific type of ship in relation to characteristics i.e. geared or gearless, voyage or time chartered and if not included in the eight types of ships dealt in my study. Significant operational, technical, contractual, financial and managerial information will be gathered, quantified, analysed and emanated conclusions could easily lead to accurate, reliable, and timely decisions so as incidents and associated liabilities to be avoided, minimised or transferred in an optimal way. This will save losses, which considered major in public concern and mostly affecting by their impacts huge geographical area of great importance. By the activity plans for employees', actions are in conformity with policies, standards, procedures, and applicable laws and regulations since corrective, preventive actions planned and placed in risk weak investigated areas of the management system and improve effectiveness and competence within the framework of the management system. Also cost saving achieved as resources are allocated economically, used efficiently, and adequately protected. Programs, plans, and objectives are more practically achievable. Key performance indicators and continuous improvement are fostered in the organization's control process. Opportunities for improving

management control and the company's image are identified within the integrated auditing system for risk management scope of work. These opportunities will be communicated to the appropriate level of management for further development and improvement of company's objectives. Combined causation chain hazard and Risk index is a good predictor of accidents of all types and should be used in Management Review for policy review and proper actions so as optimisation of the total management system will be succeeded. It increases the probability of success, and reduces both the probability of failure and the uncertainty of achieving the organization's overall objectives in avoiding, preventing or mitigating losses. Ship managers will use risk management as the ultimate management stage where proper decisions for risk defined will prudently considered and should be taken based in the assumption of risk tolerability and public acceptable level. This will improve precautionary behaviour and assessed by the insurance underwriters both for hull and machinery and protection and indemnity will reduce substantially procedures and premiums. Critical core elements that identified in my research are very good predictor of management weak areas pertinent to risk exposure and areas substantially below pre assigned values and will assist in reduction of incidents and accidents that means losses in time and money. On the personal side, my working experience at current limits of theoretical and research understanding have been utilized in collection and systematic recording of survey data and the additional skills of auditor/lead auditor and risk management I accrued within the period of the research gave me a great depth of theoretical knowledge of an inter-disciplinary nature in the complex area of safety, quality, environmental protection and occupational health which I shared with my colleagues and participants successfully. The analysis of complex knowledge base and data through research audit process, dealing with lacunae and contradictions, and confident selection of tools have been developed my maritime specialty in a new and prospective area for my project's work. Within my project I have demonstrated a creative approach for solving risk management problems and I have worked successfully with my colleagues, participants and my company's staff in groups but also I have worked independently for statistical analysis of the results and their interpretation. My project has developed and improved critical factors by collecting data, retrieving information, using resources and accepting support of all relevant societies. By presenting the results it will be a communication of information to participants and other parties involved in a professional and academic way through reports, talks or workbook presentations so as a basis for proper implementation will be created. During my research an effective selection and use of research methods have been made in action and on action by using both action research and soft systems methodology inspired and thanks to my professor Dr. Jonathan Garnett. This provided way of investigation of management system conformity with standards and codes necessary for ship management companies' certification and validation. My project has proven significant to the insurance companies as they could relate the risk ranking with risk undertaken but serious consideration and awareness of potential ethical dilemmas rose in research, auditing and analysis from the participants and stakeholders and for that reason results treated with professional attitude and ethical practice.

2.9 Applications and impact of my project

The" integrated auditing system for risk management" IASMAR is a risk management tool for weighting risk factors within the SQEOH process and should be considered an internal SQEOH management tool and up to now risk ranking scores for ship companies should considered tools for internal improvement. My research will assist the shipping industry to accomplish its safety, quality, environmental and latest occupational health objectives by bringing a systematic, disciplined approach to evaluate and improve the effectiveness of risk management, control, and operational processes within the existed implemented management system. Specifically the implementation of this project in my organizational context will have the a significant impact since the scope of the integrated auditing system for risk management will determine whether my and others shipping company's policy and objectives for safety, quality, environmental protection and occupational health are relative to the tasks of risk management, controls, resources and processes, as designed and represented by management and are adequate, integrated, properly defined and optimal used. Within the frame of this aim a flexible auditing plan for shipping activities and critical core elements will be developed in my Company by using an appropriate risk-based methodology, including any risk or control concerns identified by management taking into consideration quality assurance reviews in accordance with professional practice of internal auditing / lead-auditors standards and code of professional ethics. This will have a significant impact in my company and will improve efficiency and cost effectiveness and finally will provide necessary funds for future development. The results of my project in Maritime Industry will have a significant impact since the structure of the research is based to the ISO 9000 and ISM code's quality and safety management system for the Shipping Industry that promotes preventive measures and establish safeguards against all identifiable risks. Additionally there is a significant impact of my research to insurance companies which role is essential in operating cost of ships are of great interest and keen to adjust premiums to the level of company's risk prevention strategy since mainly rely on the quality assessment through inspections of the responsible classification society and not on the risk level systematically estimated by the management proactive level as a criteria for adjustment of the premiums and deductibles. Financial organisations are also interested to assess investment risk by the level of the exposure from the quality of the ship owner / manager. P+I clubs, Port authorities, Flag states, Classification societies and environmental authorities are very interested to address level of risk by developing rules and regulations and monitoring vessels performance. Additionally safety and environmental risk assessment will soonest performed by port authorities in order to develop emergency response plans.
Those prospects will substantially re value my research project by enhancing two covariance management and cost effectiveness. That is the reason I wanted from the beginning of this research to produce an insightful piece of work something that Ship Managers, Insurers and other ship related companies will be able to use as a resource and guide for risk evaluation of SQEOH existing ship management approaches and validate the results and metrics for which I had to extend the volume of the report above the required level.

CHAPTER THREE: MARITIME RISK MANAGEMENT

3.1 Introduction

Risk Management is increasingly recognized as being concerned with the management of both positive and negative aspects of risk. In the maritime management it is generally recognized that consequences are only negative and therefore the management of maritime risks as per ISM is focused on prevention and mitigation of harm and losses. My project describes how uncertainty in maritime management can be taken under control by rationally assessing most types of risks and planning priorities and operations activities through proper ranking audit and self assessment. However, a control can be achieved only through fully understanding the risks and the factors behind them. Thus, in this chapter we first consider the concept of maritime risk and some classifications of the risks faced in maritime business. We then turn to risk management frameworks that are discussed especially from the view of specific activity, corporate risk management and auditing process. Likelihood and consequences related to harm and loss. The overall magnitude of a loss depends on three components: 1) the character of loss, 2) the extent of loss, and 3) the timing of loss. The character of loss refers to the qualitative nature of loss: is it financial, human, environmental or other kind of harm. The extent of loss is divided into two sub factors: 1) Severity, which determines how much is lost if the risk materializes and 2) Distribution, which defines the subjects who are affected by the risk. Finally, the duration, frequency, and imminence of the occurrence of risk are involved in the timing of loss. When assessing severity a consistent approach should followed that allows each issue to be treated in a similar way and use criteria that provide a rational basis for the assessment in a systematic manner. A loss is not a precisely defined concept and in maritime industry is strongly related to the liabilities emanated in each country for each case. It is a negative change with respect to some reference level at which the outcome of the uncertainty is not considered a loss any more. The reference level can be chosen, for example, to represent a level that is reasonably achievable, expected value, or the status quo. Risk stems from uncertainty. Uncertainty in turn arises from two main sources 1) Lack of knowledge at present (subjective uncertainty), 2) Inherent uncertainty about the future. The lack of present knowledge is imposed by the limits of time, money, and resources to gather information about the present (or past) state of nature such as the current profitability of a market segment. Moreover, the knowledge is limited by the corporate secrecy of competitors and by the boundaries of human understanding. On the other hand, the future cannot be usually known for sure in advance, and most future events are thus inherently uncertain. However, some statistical methods such as regression and time series analysis can give us guidelines about which events are likely to happen in the future, but exact prediction is often impossible. In any risk management study consequences describe in a way the potential loss emanated by these if the risk materializes. Detection level is also very important for managing loss and consequences. Below is presented the analysis of loss as concluded during my project by the conceptual understanding of the participants.

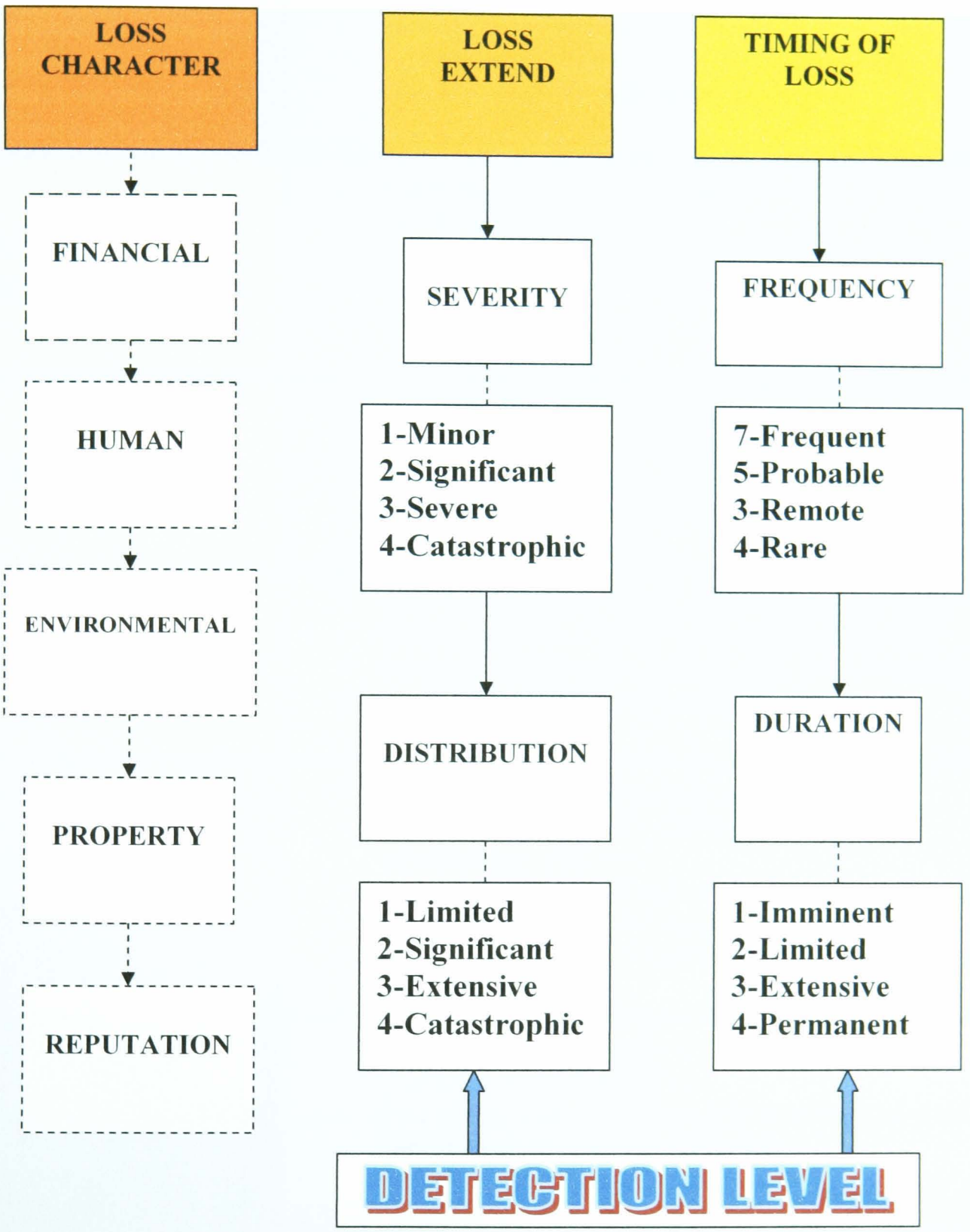


Table 3.1 Analysis of Loss

RISK MANAGEMENT STAGES AND ELEMENTS

INITIATION PLANNING	• Define the problem or opportunity • Identify Risk Management Team • Assign responsibility, authority, and resources • Identify potential stakeholders
HAZARD IDENTIFICATION	• Define scope of the decision(s) • Begin Stakeholder Analysis • Begin to develop Risk Information Base • Identify possible exposures to loss using risk scenarios
RISK ANALYSIS	• Estimate frequency of risk scenarios • Estimate consequences of risk scenarios • Refine Stakeholder Analysis through consultation • Update Risk Information Base
RISK ASSESSMENT	• Risk Management Team meets to integrate the information from Risk Analysis, including costs • Integrate benefits and update Risk Information Base • Assess acceptability of the risk
RISK MANAGEMENT	• Identify feasible risk control options • Evaluate risk control options in terms of effectiveness, cost, etc. • Assess stakeholder acceptance of residual risk • Evaluate risk financing options • Assess stakeholder acceptance of proposed action(s)
RISK AUDITING	• Implement chosen control, financing, and communication strategies • Risk Management Team evaluates effectiveness of risk management decision process • Establish ongoing monitoring process

Table 3.2 Risk Management Stages and Elements

3.2 Risk Management Framework

The draft Canadian risk management standard (CSA, 1996) defines risk management as: "the systematic application of management policies, procedures and practices to the tasks of analyzing, evaluating, controlling and communicating risk." This of course makes reference to the corporate risk management which is related and retrieves elements by the international standards for producing a management system which will enrol risk in their element and procedures. In that way risk management could considered as a central part of any organization's strategic management. It is the process whereby companies methodically address the risks attaching to their activities with the goal of achieving sustained benefit within each activity and across the distribution of all activities. The focus of good risk management is the identification and treatment of these risks. Its objective is to add maximum sustainable value to all the decisions made for the activities of the organization. Risk management should be a continuous and developing process which runs throughout the company's strategy, formulating proper decisions, implementing that strategy and evaluating the results in order to achieve continuous improvement. It should address methodically all the risks surrounding the organization's activities past, present and in particular, future. It must be integrated into the overall management of the organization with an effective policy and a program led by the most senior management. It must translate the strategy into tactical and operational objectives, assigning responsibility throughout the organization with each manager and employee responsible for the management of risk as part of their job description. It should support accountability, performance measurement and reward, thus promoting operational efficiency at all levels. The risks facing company and its operations can result from factors both external and internal to the organization. These risks emanated by the specific operation and activity considered as specific issue or activity risks. By that way can be categorized according to the type of the activity further into types of risk such as technical, financial, operational, chartering, etc. Additionally provided categories concluded from the participants of my project are risks faced by maritime companies according to the time of activity such as laden at sea, in the loading- discharging port, during discharging, during loading, at sea in ballast. Risk management protects and adds value to the company's implemented management system and increase confidence of its activities to the stakeholders through supporting the company's objectives by:

- providing a framework for an organization that enables future activity to take place in a consistent and controlled manner,
- improving decision making, planning and prioritization by comprehensive and structured understanding of shipping and shipboard activities, by controlling maintenance and damages volatility and by preventing and mitigating imminent threats.
- contributing to more efficient use/allocation of human concern, capital and resources within the company
- reducing concern in the non essential areas of the activities
- protecting and enhancing growth and company image

- developing and supporting people and the company's knowledge base
- optimizing operational and navigational efficiency

The basic stages and elements of the corporate risk management system are presented in Table 3.2.

3.3 Maritime Risk Management

Maritime companies should evolve on an ongoing basis in order to remain relevant and to meet their mandate and objective as changes occur. Mastering risk is becoming essential as part of the current evolutionary context. Risk is about something that may happen in the future. Factors such as technological innovation and complexity and growing social and cultural awareness are making it increasingly difficult to anticipate what may occur in the future. Risk management in the maritime management involves the analysis of probable incident accident scenarios about future events within shipping and shipboard activities, their likelihood, impact and acceptability to stakeholders. Shipping activities are widely spread and interacting with almost all industries by transporting goods worldwide. Thus the ship's entity is widely exposed to risks of different nature which should be avoided, prevented or mitigated successfully but also within a very limited time schedule. Ships nowadays concluding the operations in very fast and effective way and a ship which in the past needed few weeks for loading or discharging operation now is needed few days. Beside the risks in safety, occupational health and environment to which public and IMO concern is focused a significant attention should be made in financial risks faced in maritime management. This is because ships are easily held responsible, punished by fines or arrested at the calling ports by a simple judicial request of anyone considered harmed by its activities. Specifically in some geographical areas where political or social ethics of those dealing with ships consider ship as a "source of easy earnings" in combination with the mentality that "ship is a foreign entity" which is not related to the local community, like the local factory for example receiving commodities carried by the ship, resulting a significance exposure with damages to property, assets and growth. Is not something extraordinary within the shipping community the long term involvement in countries and cargos traditionally proliferating problems in quality and quantities of cargo delivered to create a huge claim which due to its nature sometimes increased exposure as became also uncovered by the insurance underwriters. Additionally of the cargo a point which involves financial risks is the Charterers entity. Charterers are the company's undertaken by the shippers or receivers transportation contracts of goods. It has been noticed that in many cases terms, reliability, conditions, type of contract and agreed measuring method put ships in huge risk exposure. Is not something extraordinary within the shipping community the redelivery and abandonment of contracts in poor market, the different agreed method of determining quantities, incidents regarding bill of ladings, deductions from hire, outstanding payments of disbursement accounts, bunkers ect. The above reference of potential treats for financial risks are only indicative and ship managers can easily bring to their minds a wide list of incidents resulting financial losses. This information is critical to issues such as the balancing of "program integrity" and "limited resources." Simply put limitations on resources can adversely affect program integrity that involves the ability of

maritime companies to ensure the continued achievement of results consistent with priorities. Maritime companies need modern management approaches including risk management to make judgments how to operate and manage activities in a way that financial growth, safety, environmental protection and occupational health will be achieved within management system's integrity. Competency in conducting intuitive and systematic analyses of the level of all risks involved during shipping and shipboard activities and opportunities will support timely decision making and demonstrate due diligence necessary for proper transfer of risks to the insurance underwriters.

Ship and shore personnel in the maritime companies manage risk every day consciously and unconsciously. During the discussions with the participants the need to do it more systematically and explicitly is the need and is mainly a matter resulted by transparency, accountability and credibility. Transparency is resulted as a matter of public opinion and maritime authorities' reform and technological developments. Transparency leads to accountability of risks, the emanated liabilities and potential effects on credibility. Integrating risk management into management and operational practices provides a basis for anticipating transparency issues, managing accountability expectations and maintaining credibility. Credibility is maintained when stakeholders gain assurance that the organization is "in conformance with anticipated standards and under control." Such assurance is gained in part when it is transparent in policy, objectives, programs, plans, reports and stakeholder communication interfaces that the ship manager carrying out its activities systematically and continually identifies, assesses and manages its risks. Risk also has a temporal nature and it should be recognized that the process is iterative, and that a return to a previous step can be made at any time. Risk management involves estimation, assumptions and implementation of strategies and procedures carried out by people. In many cases it is necessary to take a decision where all these elements have degrees of uncertainty. Most risk management approaches will examine these uncertainties and devise strategies to monitor events in order to be timely in adjusting a decision as a result of an uncertainty unfolding in a manner other than expected. Risk management includes the objectives of sensible risk taking in order to support the achievement of results. Because zero risk situations are not affordable in today's transportation environment, some level of risk taking will always be a part of decisions. However, the climate for promoting timely decisions involving risk will be undermined if there is not an attitude of allowing for adjustments after a decision has been made. Allowing for adjustment should be built into the risk management process and involve learning from the adjustment so that it will be avoided in the future. It is simply the company's preventive measures identified and distributed within the entire fleet and also the list of company's circulars in which specific orders mainly for precautionary, informative, preventive and mitigating kept as reference of lessons learnt during company's time of operation. Managers can be taken to task for not avoiding reporting a known problem but they need to feel supported in terms of there being an allowance for adjustment on areas of new uncertainty. It's a well known issue discussed among the participants the reluctance to report unwanted events or problems which actually could lead to an accident and the supporting they have in their companies for the so called "no blame culture". The discussions took place to this issue were extremely interesting and provided a clear insight

into the current conditions of people's attitude towards risks and activities which could result to an unwanted event in the area they are also present and participating in their duties activity.

Suitable data are necessary for each step of the maritime risk management process. Data varies in each port of call and often there is very limited time to collect reliable information for the ship's forthcoming activities. Data needed mostly to be collected presented but not limited to the following: navigational entry constraints, berthing prospects, loading-discharging plan, threats for human- cargo-ship, available resources, custom rules, repatriation rules, hospitalization availability, immigration rules ECT. When data are not available, advisors information, expert judgment, physical models, simulations and analytical models may be used to achieve valuable estimations and results. Data concerning specific activity incident reports, near misses and operational failures may be very important for the purposes of making more balanced, proactive and cost-effective decision. A judgment on the value of data that are to be used should be carried out in order to identify uncertainties and limitations, and to assess the degree of reliance that should be placed on the available data.

There is a requirement for extensive documentation throughout the risk management process, especially if risk to life, property or the environment is being evaluated. If the specific issues are under evaluation and review relatively inconsequential, documentation requirements may be modest, but still necessary. Documentation helps in explaining decisions, helps in defending decisions after they have been made, provides a reference for future risk management processes, so as to facilitate continuous improvement, provides for the monitoring function, provides the basis of all decisions, in that all decisions are based on information, provides a record of proceedings and helps in communicating reasons for decisions to stakeholders.

It may be critical that documentation is detailed and comprehensive, as in cases of possible litigation.

During the discussions with participants questions raised regarding excess paperwork could create a systematic risk assessment procedure for all decisions in day to day operations of shipping activities. Recalling the discussions provided for the above issue there was reluctance at all for documenting decisions involving risk assessments, thing which definitely should be influence and considered during the potential implementation schedule of risk involvement in maritime management system. Documentation should be an important resource for maritime decisions, just as a lack of documentation may generate serious problems specifically during severe accidents involving insurance payments. The amount of documentation to be provided should be a matter of serious consideration. While it is cautioned against being secretive, some information may need to remain confidential. Maritime risk management approaches are increasingly and commonly used for the prevention and avoidance of major hazards and the demonstration that risks have been controlled to an ALARP standard is adequate to prove to the public and authorities the necessary and always requested due diligence of the ship manager and his servants.

3.4 Maritime Risk Management Elements

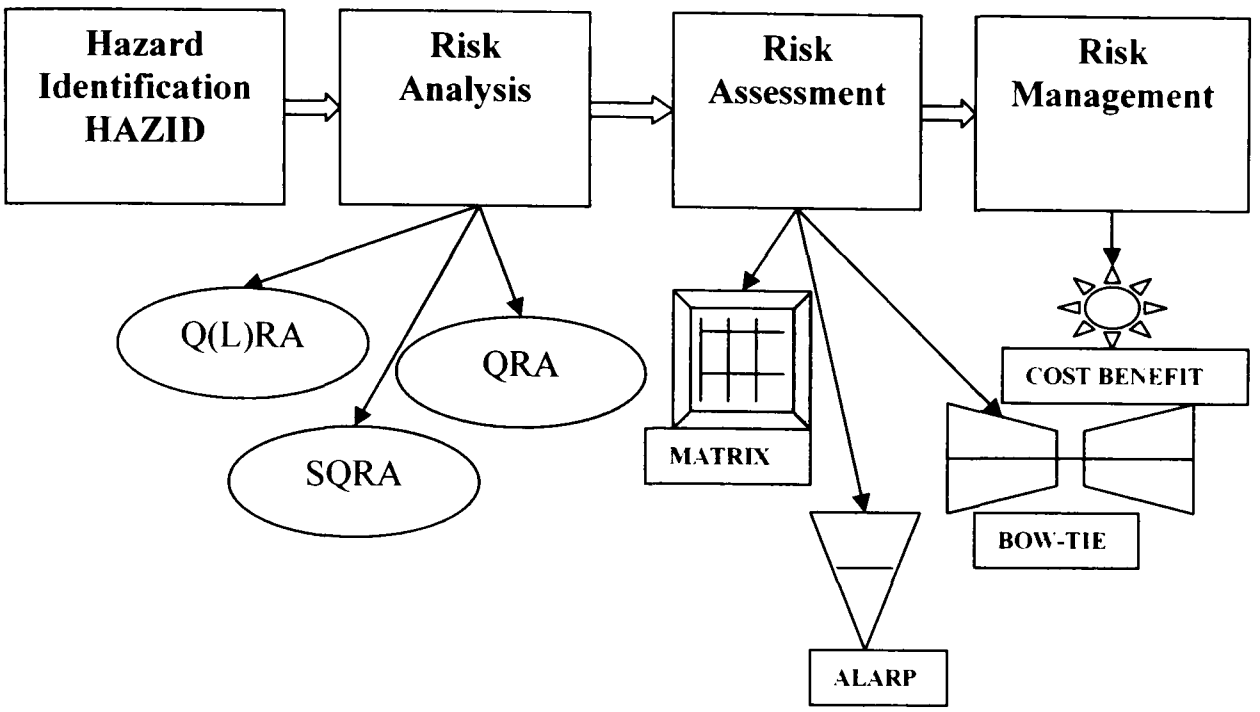
3.4.1 Initiation and Planning

Maritime activities presented in previous chapters involving risks for any number of reasons. Risks should be considered as related elements to Property, Personnel and Environment. In order to deal with risk the first and most crucial step is to clearly and adequately define the nature and the scope for the decision to be taken with respect to the problem of a potential threat. Its important that by doing that the company will save time and resources by focusing efforts. So the purpose of this stage is to clearly identify the issues to be addressed the nature and the scope of the decision to be made. At this stage is required the consideration for the following steps. Identification of the issues and assessment of the context of the decision should be made. The first step is to identify the issues that have created the need to make a decision. In some cases, this may be triggered by proposed regulatory changes but in others, they may arise from a variety of sources such as an accident or occurrence, new technology, new conditions, concern from general public or authorities. Once the issue and its associated problem have defined a brief articulation of questions for the identification of problem and objectives is placed and the identification of people who will be involved in the decision selected which are nominated as risk management team. Among these people and company's organization assignment of responsibility, authority, and resources determined as necessary as appropriate. The risk management team will place the definition of limits and priorities as well as time schedules and identification of potential stakeholders will take place for establishment of proper communication.
Based on the above framework I have placed "Nature and scope of decision" as the first part of my auditing questionnaire to demonstrate maritime company's ability to the risk deliverables which are:

-The establishment of flow chart for activities.
-The establishment of walk through revisions.
-The sequential list of activities.
-The list of probable causes and associated hazards.
-The clear statement that outlines the threat of an activity.
-The consolidation of causation hazards.
-The establishment of risk management team.
-The clear set of prioritized objectives.
-The setting of time schedules achieving objectives.
-The identification and prioritization of stakeholders.

It's uncommon but in shipping similar or same problems have different context and assessment in different ports of the world and objectives varies depend on the conditions and places. That's why participants concluded that should always keep in mind that during the completion of an assessments specific local conditions or even new elements will emerge that may greatly affect the risk assessment results and the decision making process.

Table 3.3 Risk Management and Decision Making Process



3.4.2 Hazard identification

Hazard as per definition considered as a source or situation with a potential to harm or threaten in terms of human injury or ill health or life, damage to property and to environment or a combination of these. During my first survey No 1 regarding awareness and definition of risk characteristics there was a conclusion in hazard detailed definition which is "Hazard is the property of the surrounding materials and conditions which participated in an undergoing shipping or shipboard activity the combination of which could create a potential to threaten and consequently to harm in case of loss of controls". **So it is clear that in order to have an unwanted event we should have activity, hazardous environment and loss of controls.** It is common for the staff carry out hazard identification to be confused and instead to identify hazards to identify the event caused by the hazard. For that reason I have presented below diagram which emanated from the elements of my Survey No1 for hazard identification and event caused.

Depending on the nature of the activity, the consequences and losses of an event can have different level of severity as darkness may have a greater impact on entry into enclose spaces than on navigation with controls in place. Therefore, in identifying a hazard the type of the harm to whom or what could be harmed and how could harm occur has also to be identified. Hazards could reasonably expect to result in significant harm under certain conditions in marine environment.

HAZARD EVENT AND LOSSES ANALYSIS

ACTIVITY: Walking on deck

SURROUNDING MATERIALS:
Deck surface

SURROUNDING CONDITIONS:
Raining, Night

HAZARD (PROPERTY):

Deck's slippery surface, darkness

TOP EVENT:

Slipping, falling, hitting an object

LOSSES:
Character> Human
Extend> Severity>Minor
Distribution> Limited
Timing> Frequency> Probable
Duration > Limited

Table 3.4 Hazard events and losses analysis

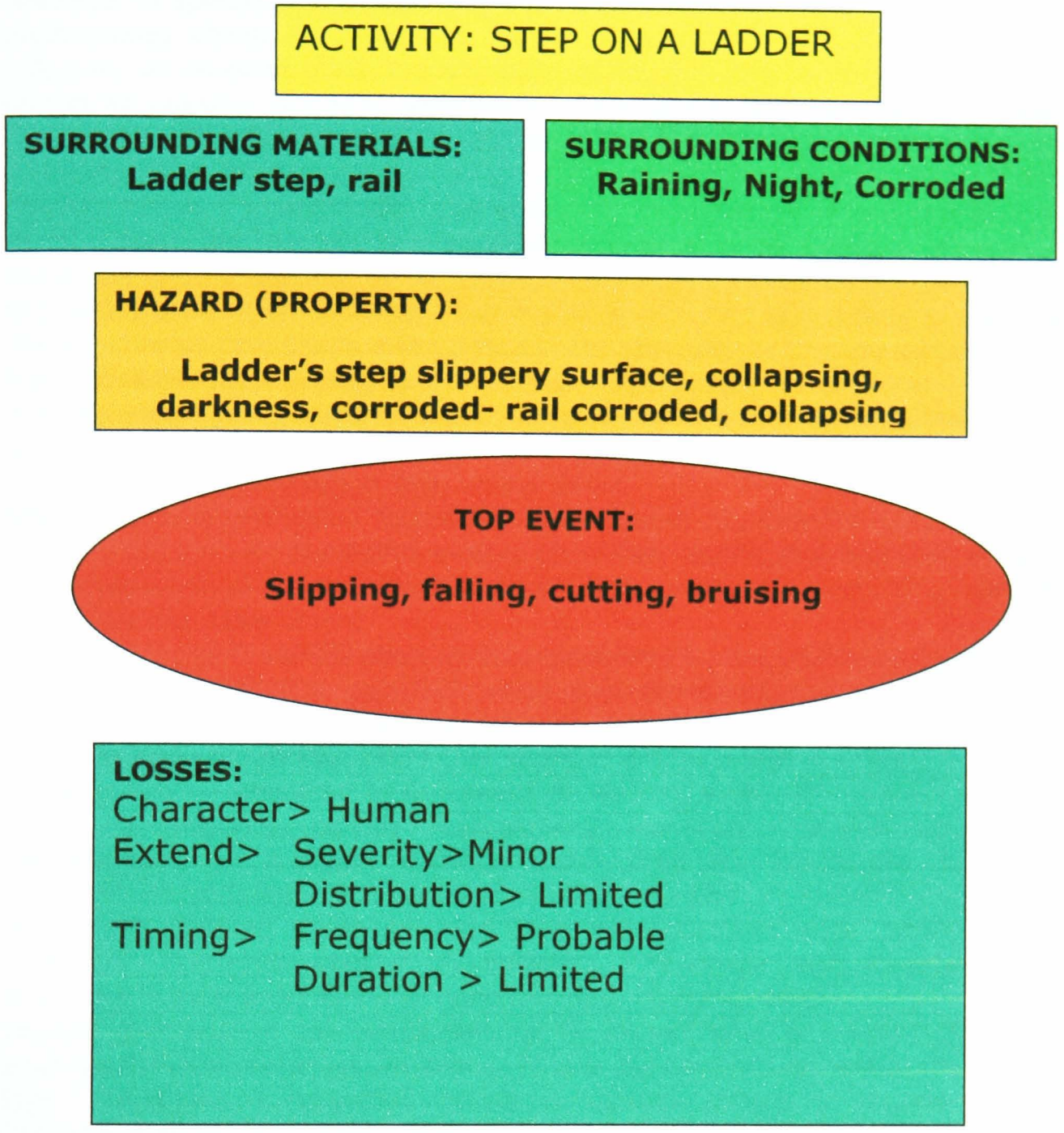


Table 3.5 Activity Step on a ladder

Examples of marine hazards presented but not limited to the following:
Slipping and tripping hazards by poorly maintained floors and stairs, fire from flammable materials ,explosion from explosive materials and chemicals on board, restricted waters, moving parts of machinery, work at height or aloft, pressure systems, moving parts of cranes, electricity, dust, weather conditions, enclose spaces tanks, poor lighting, low temperature, low visibility, shallow draft, noise, manual handling of wires ect.

Hazard identification is usually a qualitative exercise based primarily on expert judgment. Most HAZID techniques involve a group of experts, since few individuals have expertise on all hazards, and group interactions are more likely to stimulate consideration of hazards that even well-informed individuals might overlook. Hazards are diverse, and many different methods are available for hazard identification. While some methods have become standard for particular applications (e.g. FMEA for ballast system failures), it is not necessary or

desirable to specify which approach should be adopted in particular cases. The methodology should be chosen by the HAZID leader to meet the objectives as efficiently as possible given the available information and expertise. The HAZID should be creative, so as to encourage identification of hazards not previously considered. It should use a structured approach, in order to obtain comprehensive coverage of relevant hazards without skipping less obvious problem areas. It should make use of accident experience, where available, so as to capture the lessons from previous accidents. The scope of the HAZID should be clearly defined, so as make clear which hazards should be included and which have been excluded. The leader should be independent of the team (i.e. an external consultant, a risk assessment specialist or an experienced leader from another department), and has the responsibility of preventing group's thinking suppressing creative ideas. Conclusions and recommendations should be discussed and documented during the group session, so that they represent the views of the group rather than an individual.

Many hazard identification techniques are suitable not only for identification of hazards, but also for qualitative evaluation of their significance and consideration of risk reduction measures. In other works, they provide the basis for a complete qualitative risk assessment.

The key to hazard identification as also discussed by the participants is to apply the simple identification approach since over complication of threats leads to confusion and a failure to implement. There is no need for change the company's structure and operational framework since it is considered in a safe track way. Hazards can be identified in a number of different ways. The initial stage is to create a shipping activity subcategory inventory. Several areas and subcategories of shipping activities determined for identifiable threats of significant hazards for which various scenarios could be produced to lead to a top event and perhaps those involved in a procedure. In such cases a more systematic approach should be adopted. Knowledge and experience are important in such instances if all hazards are to be considered.

Hazard identification can be carried out by an individual or as part of a group exercise for more complex situations. This is the second element in my auditing plan. Prediction of projected events is directly related to causes and its associated hazards. Causes prediction is important since are easily definable and properly monitored for loss of controls. That's why analysis of causes is very important. Generally causes should be derived in ***Conditions, Human and Machine*** factors. Additionally causes which experienced in shipping activities derived in four major categories:

- **Unsafe act**
- **Unsafe conditions**
- **Human factors**
- **Technical factors**

But what is a cause and how is related to hazard and top event was the conceptual question which is being examined and investigated in my project. *Cause is the reason of the incident took place and is related with failure of proper activity implementation and lack of the control in the ongoing activity to prevent harm from the associated hazards.* To make operational activities safe controls have to be in place. These controls are put in place to minimize or negate the effect of hazards. Therefore the first step in creating a safe working environment

is the identification of hazards. This may appear to be reverse logic but it is appropriate since the effective identification of hazards is the key factor for further assessment and management.

Causes of accidents could derive in the following categories as far as regard source of causation:

Human causes; failure to read equipment correctly
Mechanical causes: failure of equipment
Fire and explosion: loss of visibility due to smoke
Structural causes: failure of strength in holds
Weather related: High or low temperature
Management systems related: company's alcohol policy not fully implemented. In the below diagram presented the causation chain and the interrelation with the activities.

Unsafe act is the direct cause of an incident including but not limited for

- operating equipment without authority
- removing / making safety devices inoperable
- using defective equipment
- Improper use of equipment
- Not using Personal Protective Equipment
- Improper lifting or task position
- Servicing equipment in operation
- Horseplay
- Under influence of drink or drugs

Unsafe conditions is the direct cause of an incident including but not limited for

- Inadequate guards or barriers
- Inadequate or improper Personal Protective Equipment
- Defective tools, equipment and materials
- Workspace restrictions
- Hazardous environmental conditions
- Noise and high or low temperatures
- Inadequate or excessive lighting
- Inadequate ventilation
- Poor house keeping

Human factors is the indirect cause of an incident including but not limited for

- Physically inadequate
- Mentally inadequate
- Lack of knowledge
- Lack of skills
- Stress
- Improper motivation

Technical Factors is the indirect cause of an incident including but not limited to

- Inadequate supervision
- Inadequate leadership
- Inadequate engineering
- Inadequate purchasing
- Inadequate maintenance
- Inadequate tools or equipments
- Inadequate work standards

Accident causation chain includes also:

Root cause is the primarily cause of an incident included but not limited to

- Lack of planning
- Lack of standards
- Lack of compliance

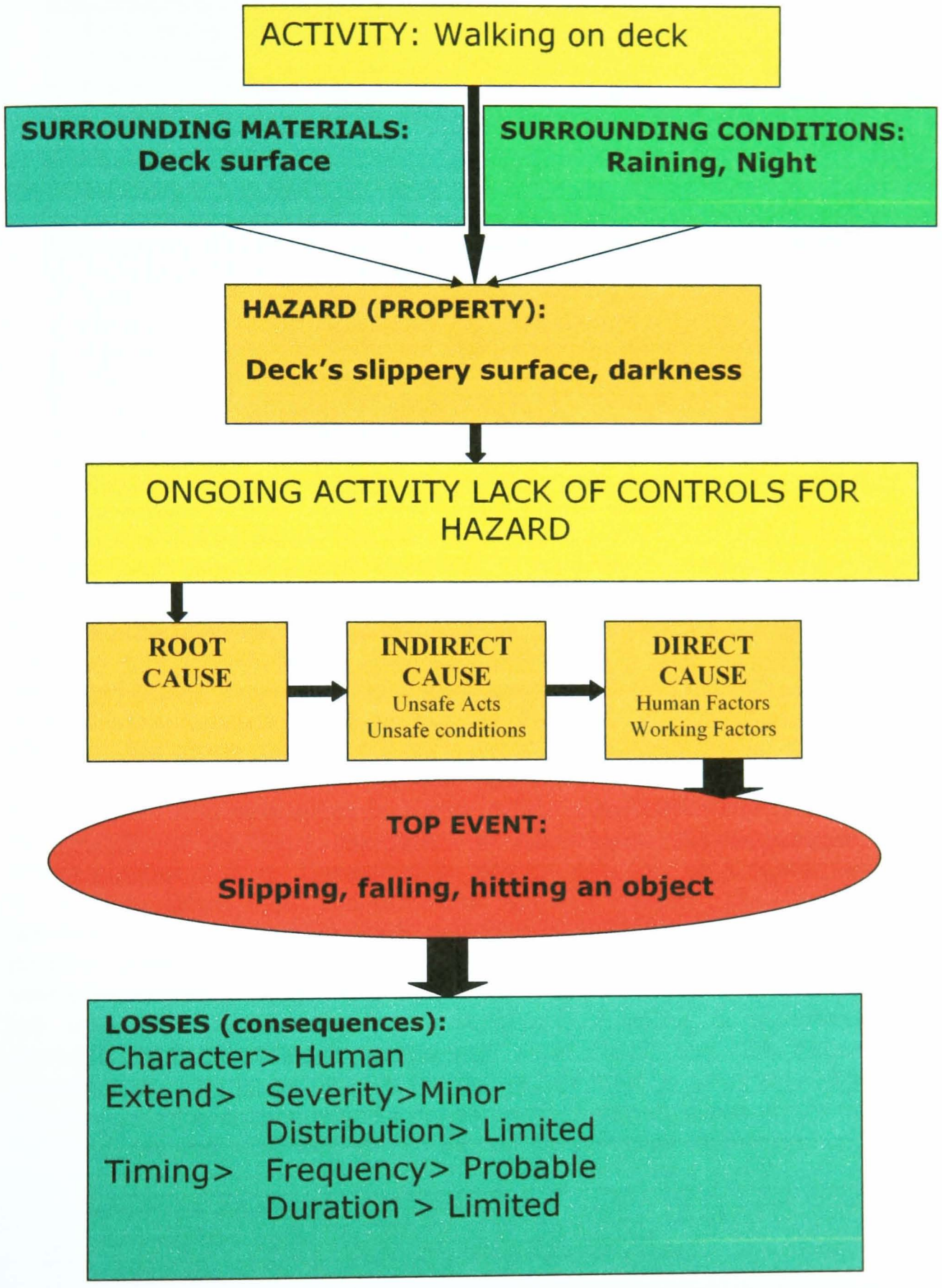


Table 3.6 Activity Walking on deck

Consequences are the resulted losses of an event of an incident included to:

- Personal injury/Death
- Ship Damage
- Property damage
- Financial impact
- Environmental damage
- Media exposure
- Reputation damage
- Commercial damage

Accident is the resulting event of an incident included but not limited to

- Pollution marine or atmospheric
- Grounding
- Collision
- Fire or explosion
- Exposure to harmful environment
- Exposure to harmful substances
- Personnel or equipment loss
- Slips or trips or falls
- Contact
- Stranding
- Hull and machinery

The approach used for hazard identification generally comprises a combination of both creative and analytical techniques, the aim being to identify all relevant hazards. The creative element is to ensure that the process is proactive and not confined only to hazards that have materialized in the past. It typically consists of structured group reviews aiming at identifying the causes and effects of accidents and relevant hazards. Consideration of functional failure may assist in this process. The group carrying out such structured reviews should include experts in the various appropriate aspects, such as ship design, operations and management and specialists to assist in the hazard identification process and incorporation of the human element. A structured group review session may last over a number of days. The analytical element ensures that previous experience is properly taken into account, and typically makes use of background information. The identified hazards and their associated scenarios relevant to the problem under consideration should be ranked to prioritize them and to discard scenarios judged to be of minor significance. The frequency and consequence of the scenario outcome requires assessment. Ranking is undertaken using available data, supported by judgement, on the scenarios. The frequency and consequence categories used in the risk matrix have to be clearly defined. The combination of a frequency and a consequence category represents a risk level.
Following are the most well-known hazard identification techniques and a short description presented as included in the Survey No1 Rev.1 and 2:

1. WHAT IF ANALYSIS
2. CHECKLIST ANALYSIS
3. HAZOP ANALYSIS
4. FMEA ANALYSIS
5. EVENT TREE ANALYSIS
6. FAULT TREE ANALYSIS
7. COMMON CAUSE FAILURE ANALYSIS
8. HUMAN RELIABILITY ANALYSIS

Table 3.7 Hazard Identification techniques

ACCIDENT CAUSATION CHAIN

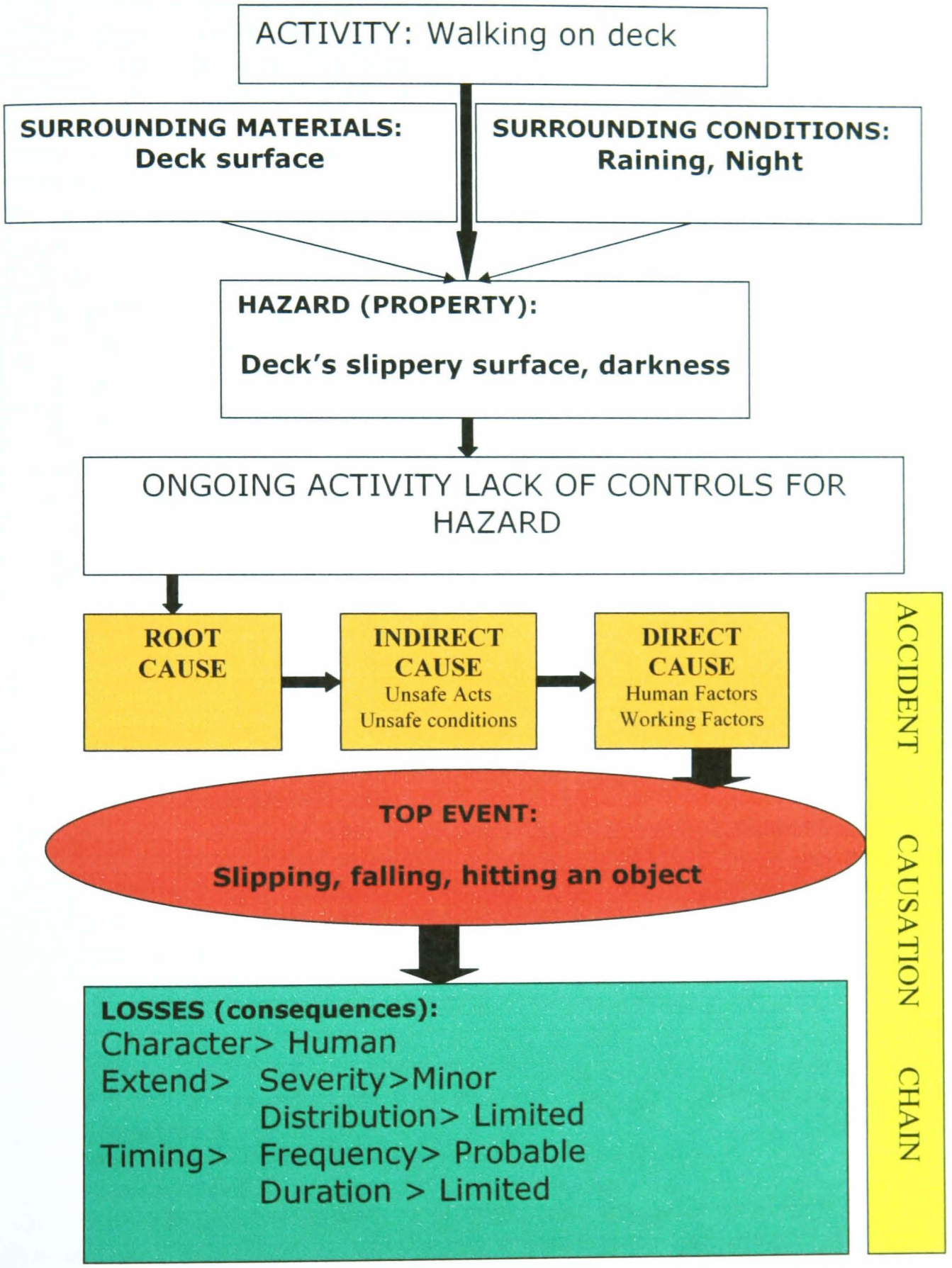


Table 3.7 Accident causation chain

3.4.3 Risk analysis

Risk analysis is the estimation of risk from the basic activity or on "as is" basis. Some hazard identification techniques described above are suitable also for analysis methods of the significance and the criticality of each hazard. Risk analysis also considered as hazard assessment and most Hazard identification techniques are not optimized for this and normally required extension to use a more formalized technique. Risk analysis can be applied in approaches described as Qualitative, Semi-Quantitative and Quantitative and the risk manager needs to decide which the right approach is for the application whether is a shipboard operation or a shipping activity.

Following are the risk analysis methods presented also in the Survey No 1.

1) PRELIMINARY HAZARD ANALYSIS
2) PRELIMINARY RISK ANALYSIS
3) WHAT IF ANALYSIS/ CHECKLIST ANALYSIS
4) HAZOP ANALYSIS
5) FMEA / FMECA ANALYSIS
6) EVENT TREE ANALYSIS
7) RELATIVE RANKING
8) COARSE RISK ANALYSIS
9) FAULT TREE ANALYSIS
10) PARETO ANALYSIS
11) CHANGE ANALYSIS
12) COMMON CAUSE FAILURE ANALYSIS
13) HUMAN RELIABILITY ANALYSIS

Table 3.8 Risk Analysis Methods

Risk analysis can be applied in approaches described as Qualitative, Semi-Quantitative and Quantitative and the manager deals with risk issues needs to decide which the right approach for the analysis. The basic aim is risk reduction and the key test is one of reasonable practicability.

In general, qualitative approaches are easiest to apply (least resource demands and least additional skill sets required) but provide the least degree of insight. Conversely quantitative approaches (QRA) are most demanding on resources and skill sets, but potentially deliver the most detailed understanding and provide the best basis if significant expenditure is involved. Semi-quantitative approaches lie in between these extremes. Risk Analysis methods derived in the following general categories:

-Qualitative Risk analysis (Risk Matrix methods, Risk Rank)

-Semi Quantitative Risk analysis (FTA, ETA, Bow-tie)

-Quantitative Risk analysis (HRA, FTA, ETA, Freq/Conseq.).

It is also very important the assessment of liabilities emanated from the impacts resulted from the incident.

Aspect is the element of organizations activities, products and services which can interact with the environment.

Impact considered any change whether adverse or beneficial, wholly or partial resulting from organization's activities, products or services.

Main impact categories got into consideration in risk analyses are:	
• HARM TO GENERAL PUBLIC	• HARM TO THE CREW
• HARM TO MARINE LIFE	• DAMAGE TO THE SHIP
• DAMAGE TO FACILITIES	• ENERGY CONSERVATION
• AIR POLLUTION	• MARINE POLLUTION
• OZONE DEPLETION	• LAND CONTAMINATION
• GLOBAL WARMING	• ACID RAIN
• RESOURCE DEPLETION	• EFFECT ON SPECIES
• NUISANCES	• EFFECT ON ECONOMY

Table 3.9 Impact Categories

Main aspect categories got into consideration in risk analyses are:
• CONTAMINATION TO LAND
• DISCHARGE TO AIR (EMISSIONS TO AIR)
• DISCHARGE TO WATER (RELEASES TO WATER)
• WASTE MANAGEMENT (LIQUID WASTE, SOLID WASTE)
• USE OF NATURAL RESOURCES

Table 3.10 Category of aspects

When assessing significance of aspects consideration must be given to significance of impact why it must be carried out.

There are several reasons for establishing significance:

- Provide focus
- Scope of control and monitoring equipments
- Training needs
- Communication establishment
- Use in auditing
- Use in management review

In determining the significance of an aspect it is necessary to clarify first the definition and scale of the impact which causes it.

This will include the clearly defined aspect of the shipping activity, the quantity of the impact and where it is originating, the area and extend of the impact, if any controls are applied and monitoring performed.

The types of incidents / accidents considered in this project are listed below and not limited to the following:

TYPE OF ACCIDENTS/ INCIDENTS	
• Act of War	• Explosion
• Anchoring operation	• Falling object
• Ballast operation and treatment	• Fire
• Beaching scrap	• Flooding
• Black out	• Grounding
• Bunkering operation	• Harmful substances
• Cargo damage	• Heavy weather
• Cargo related	• Helicopter operation
• Cargo shifting	• Ice damage
• Cargo cleaning	• Listing
• Contact float item	• Lack of training
• Contact intership	• Lashing
• Contact shore item	• Maintenance
• Contact bottom	• Manual handling
• Crane operation	• Mooring
• Crane related	• Routines
• Crew fall	• Sabotage
• Crew negligence	• Slip
• Crew related	• Structural failure
• Capsizing	• Weather damages
• Equip. failure Deck	• Wire/Rope parting
• Equip. failure E/R	• Unlashing
• Equip. loss or damage	• Unmooring

Table 3.11 Type of accidents incidents

There are several possible approaches to structuring a risk analysis model. An important consideration is to start with the right initiating shipping and shipboard events and follow with the proper estimation of likelihood and consequences in different accident scenarios. One can first divide the problem into accident types as presented above , assuming, for example, that they are either independent or not. For each accident type, one can then structure scenarios starting with the initiating activity and event and considering the subsequent events and variables sequentially.

3.4.4 Risk assessment

Risk assessment is the evaluation of risk as to acceptability.

Risk assessment is the overall process of estimating the magnitude of risk and deciding whether or not the risk is tolerable or acceptable. The purpose of risk assessment is- whether or not an activity should be permitted-whether measures are necessary to reduce risks. Its objective is to identify workplace precautions to prevent harm to people, property or the environment at the point of risk. In doing so, it is fulfilling the overall objectives of a company's risk management policy. Therefore risk assessment is a part of risk management. This normally considered on comparison with risk standard or criteria. Trial and evaluation of various risk reduction measures and control options applied to control effectiveness. The dimension of frequency (likelihood) and consequence (severity) of an incident determined at that stage and definition of occurrences described. The framework of the ALARP principal (as low as reasonably practicable) formulates the risk criteria. Risk assessment is derived in Qualitative and Quantitative assessment which are the basic approaches in estimating risk level and additional control options needed to reduce risk. The risk definitions are of little use when comparing and measuring risks. Therefore, several risk measures have been developed to document and evaluate risks, most of them being a function of a probability measure and a loss measure. These approaches may be appropriate for occupational health, environmental and safety risks in marine activities, but fall short of the analysis necessary to deal with major hazard risks. A requirement for using more risk control options and measures is that the potential loss is quantifiable and projectable on a one-dimensional scale.

In qualitative approach the severity of a risk can be quantitatively assessed by mapping the risk on a risk matrix according to

-the value of the negativity of the outcome and

- Its probability (or frequency of occurrence).

Risk matrices provide a traceable framework for explicit consideration of the frequency and consequences of hazards. This may be used to rank them in order of significance, screen out insignificant ones, or evaluate the need for risk reduction of each hazard.

A risk matrix uses a matrix dividing the dimensions of frequency (also known as likelihood) and consequence (severity) into typically 3 to 6 categories. The closer to the upper right corner the risk is situated, the more critical it is. This is a good tool in risk identification for a quick overview of risks and in order to determine which to focus on in further analyses. From this graphical point of view, risk management can be seen as striving to move risks towards the lower left corner by lowering the probability of the undesired outcomes and/or lowering the severity of their consequences. Instead of representing a risk by only one point

on the risk matrix, a curve can be drawn. There is little standardization in matters such as the size of the matrix, the labeling of the axes etc. To illustrate this, three different risk matrix approaches are presented below.

In each case, a list of hazards is generated by a structured HAZID technique, and each hazard is allocated to a frequency and consequence category according to qualitative criteria. The risk matrix then gives some form of evaluation or ranking of the risk from that particular hazard. Sometimes risk matrices use quantitative definitions of the frequency and consequence categories. They may also use numerical indices of frequency and consequence (e.g. 1 to 5) and then add the frequency and consequence pairs to rank the risks of each hazard or each box on the risk matrix. Risk matrices provide a traceable framework for explicit consideration of the frequency and consequences of hazards. This may be used to rank them in order of significance, screen out insignificant ones, or evaluate the need for risk reduction of each hazard. A risk matrix uses a matrix dividing the dimensions of frequency (also known as likelihood or probability) and consequence (or severity) into typically 3 to 6 categories. There is little standardization in matters such as the size of the matrix, the labeling of the axes etc. To illustrate this, a risk matrix approach is presented below.

An alternative, more up-to-date approach is given in the draft international standard 17776 (ISO 1999). This provides a 5 x 5 risk matrix with consequence and likelihood categories that are easier for many people to interpret.

The ISO 17776 matrix uses 4 types of consequence category: people, assets, environment and reputation reflecting current good practice in integrating safety and environmental risk decision making. The inclusion of asset and reputation risk is more for corporate well-being, but is useful as it makes the risk matrix central to the total risk decision process used by maritime companies.

A risk matrix has been proposed for a revision of the IMO Guidelines on FSA (IMO 1997) to assist with hazard ranking. It uses a 7 x 4 matrix, reflecting the greater potential variation for frequencies than for consequences. To facilitate the ranking and validation of ranking, it is generally recommended to define consequence and probability indices on a logarithmic scale.

The following table gives an example of a logarithmic severity index, scaled for a maritime safety issue. Consideration of environmental issues or of passenger vessels may require additional or different categories as identified in my survey 1. The risk index is used to rank the hazards in order of priority for risk reduction effort. In general, risk reduction options affecting hazards with higher RI are considered most desirable.

Risk = Probability x Consequence
Log (Risk) = log (Probability) + log (Consequence)

Below is presented the scales of matrix proposed by IMO for assessing frequency and severity of incidents and its resulted risk index.

Severity Index				
SI	**SEVERITY**	**EFFECTS ON HUMAN SAFETY**	**EFFECTS ON SHIP**	**S(Equivalent fatalities)**
1	**Minor**	Single or minor injuries	Local equipment damage	**0.01**
2	**Significant**	Multiple or severe injuries	Non-severe ship damage	**0.1**
3	**Severe**	Single fatality or multiple severe injuries	Severe damage	**1**
4	**Catastrophic**	Multiple fatalities	Total loss	**10**

Frequency Index			
FI	**FREQUENCY**	**DEFINITION**	**F (per ship year)**
7	**Frequent**	Likely to occur once per month on one ship	**10**
5	**Reasonably probable**	Likely to occur once per year in a fleet of 10 ships, likely to occur a few times during the ship's life	**0.1**
3	**Remote**	Likely to occur once per year in a fleet of 1000 ships ,i.e. likely to occur in the total life of several similar ships	**10-3**
1	**Extremely remote**	Likely to occur once in the lifetime (20 years) of a world fleet of 5000 ships.	**10-5**

Risk Index (RI)					
FI	**FREQUENCY**	SEVERITY (SI)			
		1	2	3	4
		Minor	Significant	Severe	Catastrophic
7	Frequent	8	9	10	11
6		7	8	9	10
5	Reasonably probable	6	7	8	9
4		5	6	7	8
3	Remote	4	5	6	7
2		3	4	5	6
1	Extremely remote	2	3	4	5

Table 3.12 Likelihood, severity and risk index

Quantitative risk analysis (QRA) is one of the most used sophisticated techniques of risk assessment, but should only be used where it used clear elements of data.

Even for these decisions, QRA is only one of several inputs to the decision-making process, and must be balanced against other approaches such as engineering judgement and company values. QRA as an engineering tool provides good understanding of the mechanisms of accidents and the role of safeguards in terminating accident sequences. It forces all assumptions to be explicit, and hence provides a better understanding of uncertainty than judgement-based approaches. In quantitative determination of Frequencies and Consequences one of the most basic risk measures is the expected loss. In this method, the potential consequences, losses, of the undesired events and their probabilities are quantified. The expected value of the loss is calculated based on this information and collected data and the expected loss is calculated simply by multiplying the loss by its probability and this measure is subjective containing the decision maker's view. For those seeking an objective risk measure, this is obviously a drawback. As one could expect, another problem is to find a proper utility function. A slightly different point of view can be gained by transforming the expected loss and expected lost utility as risk per time unit.

QRA usually maintains a clear distinction between two important elements of risk:

- ✓ The frequencies of events, i.e. their likelihood in a given time period.
- ✓ The consequences of events, i.e. the fatalities, damage or pollution that they cause.

A hydrocarbon leak resulting in a fire or explosion is often considered the typical accident scenario. This provides a clear distinction between the causes and likelihood of hydrocarbon leaks (frequencies) and the effects of fires and explosions on people, property and the environment (consequences). For marine hazards distinctions between frequencies and consequences are less clear, and each type of hazard must be considered separately. For example, the frequency of loss of position-keeping is clearly distinguished from its consequences. However, one of its consequences may be a contribution to the frequency of collision. Collisions themselves have their own consequences. For many marine hazards, such as loss of stability, it is difficult to consider the frequency without having defined the consequence. The risks may be determined by defining a range of consequences and estimating the frequency of each. Hence, for marine hazards, the frequencies and consequences are interdependent, and the major distinction is between the different types of hazards. Nevertheless, the methods of frequency analysis and consequence modeling are often applicable in principle to all hazards. Failure cases are specific hazards suitable for modeling in the risk assessment, forming discrete representations of the range of accidents that might occur in reality. Failure cases are sometimes known as "hazardous events", "accidental events", "top events", or more accurately as "equivalent discrete failures" and sometimes confusingly as "hazards". The selection of failure cases has an important effect on the overall risk results, since if too few failure cases are used, the risks and the benefits of risk control options may be unreliable. In addition to qualitative and quantitative risk assessment frequency and consequence assessment methods are used commonly in risk assessment for safety, environmental, occupational health and quality risks. Frequency analysis involves estimating the likelihood of occurrence of each failure case. The main approaches to estimating frequencies are:

FREQUENCY ESTIMATION METHODS

1. Historical accident frequency data
2. Simulation
3. Event tree analysis
4. Human reliability analysis
5. Judgmental evaluation
6. Bayesian analysis
7. Event Tree Analysis (ETA)
8. Fault Tree Analysis (FTA)
9. Common Cause Failure Analysis (CCFA)
10. Human Reliability Analysis

The consequence assessment modeling typically involves the use of analytical models to predict the effect of a particular event of concern. Most consequence modeling today makes use of computerized analytical models.
Use of these models in the performance of a risk assessment typically involves four activities:

- Characterizing the source of the material or energy associated with the hazard being analyzed
- Measuring or estimating (using models and correlations)
- Identifying the effects of the propagation of energy or material on the target of interest
- Quantifying the health, safety, environmental, or economic impacts on the target of interest

A considerable empirical database exists on the effects of fires and explosions on structures and equipment, and large, sophisticated experiments are sometimes performed to validate computer algorithms for predicting the atmospheric dispersion of toxic materials. All of these resources can be used to help predict the consequences of accidents. But, only those consequence assessment steps needed to provide the information necessary for decision making should be performed.
As stated in the previous sections, while the objective of risk assessment is the control of hazards, its purpose is to ensure that a careful examination of shipboard operations is carried out to determine what can cause harm and that any planned or existing controls are adequate. When a risk is evaluated, it is with existing or planned controls in place. In case the evaluation indicates that the risk is too high, then the controls used to evaluate the risk are not adequate and steps should be taken to reduce the level of acceptable risk. Such a process is repeated until the risks are acceptable or the operation designated unsafe and not carried out.

3.4.5 Risk management

Risk management is the process of selecting appropriate risk reduction measures and implementing them in the on going ship management. The purpose of risk management is to select which of various risk reduction measures tested and evaluated in risk assessment should be finally selected, involving different combination of safety and expenditures. This will result to how much

should be invested in enhancing the safety and efficiency of the shipboard operation. Cost-Benefit Analysis is the most common technique for comparing the cost of risk reduction measures and benefits of measures in terms of averting risk cost of an incident which has been adopted by IMO and included in FSA.
The purpose behind almost any risk management process is to support a decision making on safety and environmental matters. Decisions in shipping activities related primarily on whether or not this activity should be permitted and whether measures are necessary to reduce these risks. In case additional control options are considered necessary, involving different combinations of safety and cost, a detailed and systematic analysis should take place for proper selection. How much will be invested in enhancing the safety of an activity to the operational, economic, social, political and environmental issues related to the importance of consequences, engineering judgement, good practice and implied maritime codes and standards. The area at which risk is considered acceptable means that meets criteria set by the rules or by the best practices. Risk acceptance criteria are important to measure the acceptable level of risk and liabilities emanated from undertaking.
Two types of measures could reduce risk levels, preventive considered measures taken place before the top event and focused to reduce likelihood and avoid or transform the top event and to minimize its consequences and the mitigation measures focused on reducing severity of consequences within an acceptable level. The risk acceptable level and the level of the emanated liabilities depend mainly from societal perceptions and priorities, is very difficult to determine acceptable levels of risk. The Risk Managers should analyze all various alternatives and evaluating residual risk after considering control measures in place and additional measures could develop at a first instance with reasonable cost. Measuring levels of acceptance laid to the ALARP principle according which every employer should ensure, so far as is reasonably practicable, the health, safety of employees and environmental protection.

"Reasonably practicable" is a narrower term than "physically possible" and implies that a computation must be made in which the quantum of risk is placed in the one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) is placed in the other, and that, if it be shown that there is a gross disproportion between them - the risk being insignificant in relation to the sacrifice - the defendants discharge the onus on them [of proving that compliance was not reasonably practicable]. This computation falls to be made by the owner at a point of time anterior to the accident.

Above a certain level, a risk is regarded as intolerable and cannot be justified in any ordinary circumstances. Below such levels, an activity is allowed to take place provided that the associated risks have been made as low as reasonably practicable. In pursuing any further safety improvements to demonstrate ALARP account can be taken of cost. It is in principle possible to apply formal cost-benefit techniques to assist in making judgements of this kind. It is impossible to represent with precision what is or is not acceptable to the public. This varies between individuals, and alters with time, accident experience and changing expectations of life. "Tolerability" does not mean "acceptability". It refers to a willingness to live with a risk so as to secure certain benefits and in the confidence that it is being properly controlled. To tolerate a risk means that we do not regard it as negligible or something we might ignore, but rather as something we need to keep under review and reduce further if and as we can. For a risk to

be "acceptable" on the other hand means that for purposes of life or work, we are prepared to take it pretty well as it is. When risks are expressed in qualitative form, the criteria to help evaluate their significance are usually expressed on a risk matrix which is divided into "unacceptable", "tolerable" and "broadly acceptable" regions.

The precise positioning of the bands is rather arbitrary, since the qualitative definitions of the frequency and consequence scale are too. The important message is that both high frequency and consequence are undesirable, and that low risk is only achieved by making both low.

Semi-quantitative approaches to risks, such as bow-tie analysis are not normally suitable to evaluate the acceptability of the risks. They are optimized to highlight the safeguards that are in place, and to ensure that suitable safeguards are considered for each hazard.

The following is a list of some of the control measures that may need to be considered.

- Provision of training and information
- Safety management system
- Warning signs
- Restriction of unauthorized access
- Detection systems for leaks
- Impact protection
- Spills clean-up procedures and equipment
- Manage/control temperatures, humidity, other stability factors
- Eliminating ignition sources in areas where flammable atmospheres may exist
- Spills containment measures
- Emergency plans as required
- Segregation of incompatible materials
- Mechanical ventilation
- Ongoing inspection and maintenance
- Provision of personal protective equipment
- Separation of protected works
- Management of dangerous goods
- Managing and preventing overfilling
- Prevention from release of vapor
- Emergency Services
- Provision of fire fighting equipment
- Provision of safety equipment
- Marking of areas
- Control of credibility
- Third party inspections

It is very important at this stage the assignment of responsibilities for all staff involved in Risk management process.

Managing Director or Chief Executive Officer has responsibility for ensuring that:

- The Risk based Safety, Quality Environmental and Occupational Health and Safety Policy and Guidance is implemented throughout the Company.
- All hazards are identified and risk assessed.
- Action is taken to eliminate or control those risks so far as is reasonably practicable.

Company's Directors

- Directors are accountable for the implementation of the risk based Company's policy and guidance throughout their areas of responsibility within the Company.

All Company's Managers are responsible for:

- The implementation of this policy and guidance throughout their areas of responsibility.
- Ensuring that Hazard Identification and Risk Assessments are undertaken within their areas of responsibility.
- The introduction of suitable and sufficient measures to eliminate or adequately control a risk, and that those measures are regularly reviewed to ensure there use and adequacy.
- Ensuring that where there is a significant risk from a specified hazard, that this is formally recorded using the documentation provided within the policy and guidance.
- Reporting to the Risk Manager all identified risks and the measures to be implemented to either eliminate or control those risks.

Risk Manager is responsible for:

- Investigating all cases of significant residual risk within the Company.
- For maintaining the Company's Risk Inventory
- For notifying Top Management, through the Management Review meetings for all areas of significant residual risk.

Competent Officers assigned as Risk Officers are responsible for:

- The day to day management of the hazard identification and risk assessment process on board the ships. This includes the maintenance of relative records
- Notifying the Risk Manager ashore of any significant hazards/risks identified within the ship's activity area for inclusion in the inventory of shipping and shipboard activities.

All Crew Members or shore Staff employed by the Company is responsible for

- The identification of hazards throughout their duties of work.
- Reporting hazards to the Risk Manager or Risk Officer onboard immediately when and when identified.
- Assisting their Risk Manager or Officer with undertaking risk assessments within their duties of work.
- Complying with all measures that have been introduced to eliminate or adequately control a particular hazard.
- Notifying their Risk Manager or Officer of any breakdown in measures that are used to control a hazard.
- Where stevedores or other employees work in ship's premises, they should also familiarize themselves with any Company's arrangements with respect to hazard identification and risk assessment.

In order the Company to keep a minimum standard of Risk Management a documentation system should be used in conjunction with Company's policy and guidance. There are used in a minimum two forms;

- **Hazard Identification Form** – to be used at the initial point of the process and for the reporting of Hazards up through the risk management.
- **Risk Assessment Record** – to be used for risk assessments in case further and more detailed investigation needed.

It is sometimes claimed that the precautionary principle may very well be sound, but it is a principle only for risk managers, not for risk assessors. There is some evidence that the actual application of precaution must take place in the decision that the decision maker takes. However, this does not mean that the

precautionary principle puts no demands on the expert who performs risk assessments. In order to be able to make decisions that accord with the precautionary principle, the decision maker needs to have information not only about scientifically well-established risks, but also about scientifically sound indications of risk. There must be a communication of such indications from risk assessors to risk managers.
In the case studies carried out in this project both forms have been used successfully for risk management and ranking of risks
Next is needed to assess the cost and effectiveness of putting additional control measures into your operation. How costly will this potential solution be and how much it reduces the relative risk score is the main issue to estimate either by an engineering study or by draft estimate. It is needed to estimate the cost and the effectiveness of each countermeasure, whether it's rearranging work schedules or procedures, installing new equipment, or providing additional training for the crew. The following rating scale was used in the project for cost and effectiveness estimate
LOW (1): Low or no cost. No reduction in the relative risk score
MEDIUM (2): Approximately equal to the revenue received on a good day. Reduction of the relative risk score by one or two points.
HIGH (3): Greater than the revenue received during a week or more of operation. Reduction of relative risk score in excess of two points
Finally is needed to assess the COST-BENEFIT (VALUE).
By putting everything together, combine the results from the above cost effectiveness rates and estimate of effectiveness and the cost estimate. This will give you an idea of which countermeasure prioritization. This resulted by dividing the estimate of effectiveness by the cost estimate and by which a rank of immediate, intermediary and long term investment in control options organized.

3.4.6 Risk auditing

Risk self assessment and auditing is the process of monitoring and incident investigation selecting appropriate auditing internal data. Audits are the basis for an organization's self-assessment of its capability to continually assess overall risks according to stakeholder requirements related to quality, safety, environment and occupational health. Risk management systems provide the organizational means to ensure this capability, and audits are required to assess the appropriate implementation and effectiveness of these systems.
Auditing is an important element of the Plan-Do-Check-Act cycle on which the well known management system standards, such as ISM, ISO 9001 and ISO 14001, OHSAS 18001. ISO 19011: 2002, Guidelines for quality and environmental management systems auditing set the scene for more standards that cover general management system techniques. Audits are the basis for an organization's self-assessment of its capability to continually comply with stakeholder requirements related to e.g. safety, quality, environment and occupational health and safety. Management systems provide the organizational means to ensure this capability, and audits are required in the management system standards to assess the appropriate implementation and effectiveness of these systems. Combining management system audits has financial and practical advantages and does not affect the reliability and usefulness of the audit outcomes. For many organizations, the audit program will consist of the set of

individual audits which are carried out to cover all elements of the management system. An audit is a systematic, independent, and documented process for obtaining audit evidence and evaluating it objectively to determine the extent to which the audit criteria are fulfilled. Auditing is also a process that needs to be planned and controlled to provide a reliable outcome. The audit process needs to be systematic, following well-established procedures. During the audit, relevant information is gathered and selected (Auditing Collected Data) which is verifiable information that is assessed against the audit criteria. Information can, for instance, be records or statements made in an interview; crosschecking can be used to verify this information that can then be assessed against the requirements of an internal procedure. Such assessment lead to findings of the most "risky" areas of shipping and shipboard activities which additional care and control options needed to be placed and key performance indicators placed for non-conformities. An audit does not only provide information to determine conformity, but also information of risk assessment that can be used to direct an organization and improve its activities. This added value of risk auditing compared to control or inspection activities – is, amongst others, related to the in-depth type of investigation and analysis of risk based shortcomings or non-conformities that form the basis of all audits. Risk audit derived in 20 sections described below which have been derived in sections in relation with the elements dealt in the implemented management system. These have created relative questions aiming to assess company's conformance with management system's standards and risk management standards and to create a gap analysis for the departments of the company and possible areas of improvement. Below presented the 20 elements used in the Survey No 3.

ELEMENTS FOR AUDITING AND SELF ASSESSMENT	
A.	NATURE AND SCOPE OF DECISION
B.	MANAGEMENT RESPONSIBILITY
C.	STAKEHOLDERS ANALYSIS
D.	RISK SCENARIOS
E.	PERSONNEL RECRUITMENT
F.	OPERATIONS AND NAVIGATION
G.	HAZARD IDENTIFICATION
H.	CARGO OPERATIONS
I.	BALLAST OPERATIONS
J.	MOORING OPERATIONS
K.	RISK ANALYSIS
L.	PLANNED MAINTENANCE
M.	RISK ASSESSMENT AND ESTIMATION
N.	RISK MANAGEMENT AND EVALUATION
O.	ACCIDENT & INCIDENT INVESTIGATION
P.	SAFETY MANAGEMENT
Q.	ENVIRONMENTAL MANAGEMENT
R.	RISK PREPAREDNESS AND PLANNING
S.	QUALITY MANAGEMENT
T.	RISK SELF ASSESSMENT & AUDITING

Table 3.14 Critical Core Elements

3.4.7 Maritime Risk Management and Decision Making

The risk based decision making process is intended to assist decision makers in maritime management to acquire, analyze and evaluate the information needed to make decisions in areas affected by risk. The process is designed to help decision makers arrive at informed judgments as to the significance of a risk, what level of the risk is deemed acceptable, what level of control might be appropriate, and how to communicate about the risk with stakeholders. Further, it outlines methods of establishing specific actions that may be desirable with respect to the risk, and implementing and checking the effectiveness of those actions. The guideline presented above presents in detail the considerations in moving from one stage of the process to the next, the options at each point being to end the process, go to the next step, take a specific action, or go back and obtain further information. The decision as to what to do is based on the decision maker's comfort level with the extent of available information, the apparent characterization of the risk, and the acceptability of a decision to do nothing or take a specific action. The process allows decision makers to take obvious actions and review aspects in more detail at the same time. Using the process properly forces an organization to develop specific criteria for determining levels of risk acceptance (not identical, but related to determining significance). Determining the absolute values for the consequence / frequency relationship thresholds between acceptable, tolerable and unacceptable risks can be a very difficult exercise. A diversity of information may need to be applied, including technical risk assessment results, the sensitivities of interested public groups, government expectations, industry norms and standards, company policies and so on.

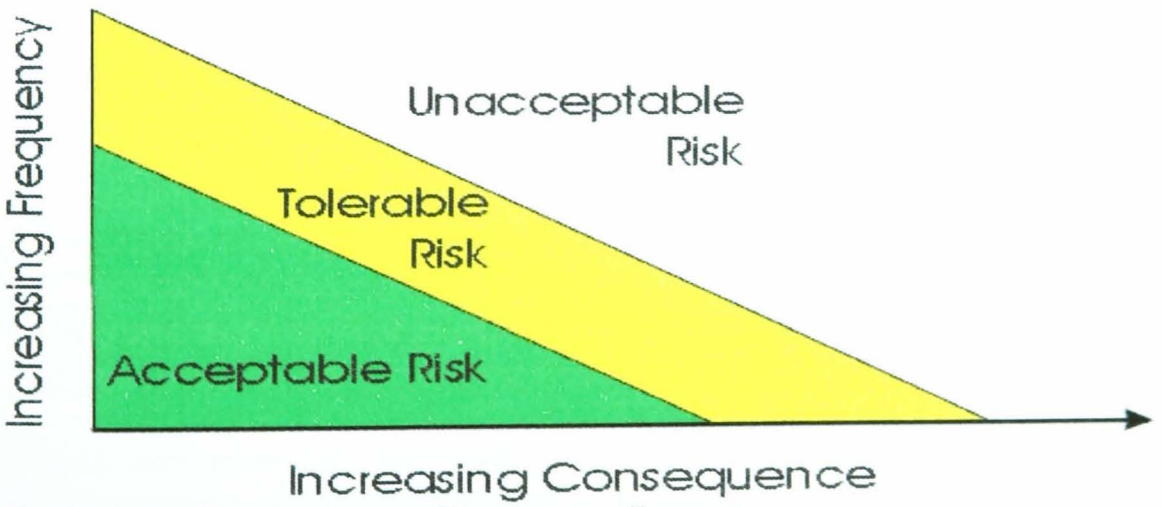


Table 3.15 Consequence-Frequency diagram

Particularly helpful to management, the process establishes a consistent procedure that can be applied to risk-based decisions. Consistency enhances the ability to review and improve performance - one of the aims of the monitoring component of the 'Action' step of the process.

At this point it is helpful to point out the distinction relationships between issue-specific risk management and corporate risk management. The risk management decision process is suited to decisions and subsequent actions regarding specific risk issues (issue specific risk management). Corporate risk management sets the framework in which to identify and make decisions regarding individual risk

issues, to place individual risks in the overall context of corporate priorities, and to monitor and evaluate ongoing performance - both of the ability to make risk-based decisions and the success of their results. Specifically, the setting of acceptability thresholds in the Consequence-Frequency assessment of a risk is one example of where the corporate approach should set parameters for issue-specific decision making. In this and all relationships between issue-specific and corporate risk management, communication between those responsible is essential: risk decision makers must understand the corporate context, and those who set the context must understand the risks. A further relationship between issue-specific and corporate risk management exists when an organization determines to apply consistent process to studying and addressing all risk issues. Such consistency allows evaluation and improvement of performance and, along with setting consistent decision making criteria, forms the basis of a true corporate risk management system. As risk management decision process is typical of recent descriptions of the issue-specific risk management process, with the exception that the 'Initiation' and 'Action' steps link this process firmly to the higher level of corporate management, as opposed to being simply a way to make decisions about individual projects or risk scenarios.

There are seven elements of successful corporate risk management:

- Commitment to an integrated safety management system and a set of safety values;
- Priority setting based in part on the analysis of risks, usually in numerical form, supported by data and a knowledgeable staff;
- Willingness to audit and review safety systems, often by external people;
- Communications, feedback and corrective action based on monitoring of safety, e.g. retraining, conflict resolution, implementation of redundancy, safety exercises, etc.;
- Willingness to revise organizational and management structure when monitoring and data indicate there is a problem, this might include reassignment of responsibilities and introduction of periodic internal audits.
- Policies for change management that assign a higher level of care for potentially more hazardous changes;
- Active participation in external standards organizations, conferences, community emergency planning, etc.

These elements are intimately related to corporate management culture, and fundamentals of the organization's structure, supported by specific, consistent procedures. There is an absolute need for those responsible for risks in an organization (senior management) to know pertinent information about the risks, and for senior management to have the capability to manage the risks. Pertinent information to know includes: the magnitude and sources of the risks; scenarios for the higher risks; the needs, issues and concerns of stakeholders; strategies for risk control; and measures of performance against risk levels and stakeholder trust. The capability should be at the level of understanding, responsibility and authority to assess the risk, control the risk and monitor the risk.

3.5 Maritime Risk Management implementation

International Maritime Organization, the Maritime Safety committee and the Marine Environmental Protection committee approved interim guidelines for the Application of Formal Safety Assessment (IMO Circular MSC/Circ.335) as a proposed approach and process for assessing maritime risks. Additionally MEPC 392 has taken under consideration and latest guidelines considered up to now for further developments

The use of risk assessment techniques has grown significantly in recent years as a reaction to an escalation of tragic marine accidents caused serious consequences in terms of both safety and environment. Risk management is now an applicable technique for ship managers to address all potential hazards in a structured manner , and ensure risks have been to reduced to appropriate levels cost effectively.

The Management systems which are applicable and implemented to the Shipping industry are:

-The International Safety Management System (ISM Code) which is now mandatory for all ships

-The Quality Management System (QMS) according to the ISO 9001/2000 which is voluntarily implemented by the companies which would like to provide quality services

-The Environmental Management System (EMS) according to the ISO 14001 standard which is also voluntarily implemented by the companies which would like to keep aware of the interaction that shipping activities have with the environment.

-The Occupational Health and Safety System (OHSAS) according to the OHSAS 18001 standard which is also voluntarily implemented by the companies which would like to keep aware of the occupational health and safety within the internal shipping activities affecting the ship and the crew. All four Management systems mentioned above consisted generally of similar components with different aims, ISM is aimed mainly at meeting safety and operational requirements, QMS is aimed at meeting customer requirements, the efficiency of the production process and continuous improvement, EMS is aimed at these and more stakeholders requirements has expanded to include regulatory and other potential environmental requirements, continuous improvement is not only driven by stakeholders expectations by also by priorities and objectives generated internally by the company. ISO 14001 does not replace ISO 9001 and this also does not replace ISM but a company with an ISM registration has a good foundation for ISO 9001 and ISO 14001and all three are part of a maritime organization overall Management System Integrated Risk Management system (IRMS).

Additionally occupational health and safety consistent with OHSAS 18001 standard is aimed at meeting health and safety requirements related to inside ship activities and is a part of a maritime organization overall Management System additionally to the previous mentioned three management systems. Irrelatively of how many of the above management systems a Maritime Company implementing Risk Assessment and Risk Management can assist in gathering and analysis of the needed information as well as in the decision making process. Much of the maritime management has to do with managing risk

consciously or not on an ongoing basis involving technical, operational, regulatory, legal, financial, environmental and other pertinent risks.
Risk assessment and risk management frameworks intended to be used and have much to offer in an ISM shipping company particular to those contemplating establishing a Quality and Environmental Management system.
ISM requirement in section (1.2.2.2) states that 'the safety management objectives of the Company should inter alia:
-establish safe guards against all identified risks
QMS requirements of (4.1.b) are to determine the significance and interaction of the processes.
EMS requirements are to explore the significance of its effects in the environment (4.2.1) and establish objectives and targets with respect to its environmental aspects (4.2.3).
OHSAS requirements are to explore the significance of planning for hazard identification, risk assessment and risk control (4.3.1).
The maritime management is now familiar with the use of qualitative techniques. Techniques such as HAZOP (hazard and operability study) and FMECA (failure mode, effect and criticality analysis) are largely equipment based, comparatively cheap and readily applied in making design, operation and maintenance decisions. However, being qualitative, they rely heavily on expert knowledge and usually are only applied to a small section of plant or equipment. As a result, qualitative methods are effective in assessing system hazards but not securing improvement and development in control measures.
Semi-quantitative techniques allow some relative risk ranking, but are unable to provide detailed assessments of system safety, or the effects of frequency assessment and redundancy features. Neither can effectively be used in the modeling and prediction of low frequency- high consequence events – i.e. catastrophic risks. Quantitative methods overcome these shortfalls and are ideal for operation, maintenance and safety applications where some data is available and decisions on system safety and criticality are to be made. Even very basic reliability analysis of maintenance data can be used effectively in determining optimum maintenance intervention, replacement intervals or monitoring strategy. Quantitative methods include many reliability-engineering methods. These are usually used in conjunction with some more sophisticated quantitative techniques such as Fault Tree and Event Tree analysis, which have been successfully used for assessments of large scale systems in many industries. In particular FTA is able to reflect all possible failure modes and is also able to model effects of common cause failures and human unreliability.
However, use of quantitative techniques requires a more disciplined approach to recording and interpreting incident, accident and reporting and information and the modeling of that information. There is a growing recognition of the value and effectiveness of quantitative studies. Particularly when assessing system hazards, numerical results from such studies can be used in estimating the likely range of risks to employees, plant, society and the environment. Quantitative results can also be used in cost benefit studies, budgeting programs and for demonstrating that risks are ALARP (as low as reasonably practicable). At the far end of the risk spectrum are catastrophic risks, i.e. risks arising from rare events that carry high consequence i.e. multiple fatalities or serious injury, environmental pollution and major asset loss. Not all risks require treatment; some risks are

negligible or acceptable (based on either a recognized standard or company guideline), while others require due consideration based on their magnitude and criticality within the operation. In many cases, application of one particular risk analysis method, usually a qualitative one will suffice, but as the issues become more complex, quantitative methods may need to be considered. Most accidents and incidents can be traced back to either some form of equipment malfunction, operator error or an incorrect management decision.

While even simple maintenance strategies for safety equipment and operational procedures are able to yield equipment reliabilities of 80 - 90%, basic analysis across a number of industries including maritime has shown that human unreliability (or interference) continues to cause more than 80% of all system interruptions. As maritime activities and operations remain relatively people intensive, considerable effort is required in assessing human reliability and translating the results into focused training and drills regimes, better decision making or procedures (such as effective permit to work systems) for hazardous and high-risk activities.

Further improvement in safety equipment operation and condition, as part of a quantitative risk-based maintenance approach, can only be achieved through accurate collection and analysis of safety equipment failures and technical risk and operations related information.

Maritime management systems have been under development since 1998 when the implementation of ISM code became mandatory for all types of ships. Many ship management companies were decided to do more than ISM and implemented simultaneously Quality management system QMS according to ISO 9001:1996 and latest 2000 version. According to this standard the concept of providing quality services maritime managers define as clients' ship-owners and Charterers. Some of these companies also extend management systems for environmental protection by following standard ISO 14001:1996. This enhanced the idea of management systems that provide decision support for undertaking contracts with specific requests and deciding how funds and resources should be allocated to meet safety, quality and environmental protection objectives. The safety and occupational health management system for the crew is generally the earliest of the implemented management systems and to my knowledge only few companies have separately implemented. All these four management system produce an integrated management system state of the art in which all management requirements are met and performance indicators emanated from the implementation prove the effectiveness of the system and finally the continuous improvement which is the cornerstone of all management systems.

The objective of this study was to develop an auditing plan for an integrated maritime management system under which proper assessment of systems core and specific elements will be assessed within management organizational structure and final ranking will be produced for system's assessment. Another area of auditing integrated management system is risk management. The various accidents recently happened across the shipping activities initiated the need for formalized concepts of risk management systems and the Formal Safety Assessment (FSA) proposed for that by IMO. The FSA focused on the rule making decision making process and interim guidelines issues for testing and guide future rules and regulations, using the concept of sufficiency rating operational obsolescence and structural deficiencies.

Cost is also one of the important factors in developing and implementing an integrated management system for any type of ship. For an economically feasible management system, the benefits provided by the system should be higher than the cost of implementing the system itself. These costs include the expenditures during the operational service procedure, expenses of training the personnel and maintenance costs should be considered on basis of first implemented on the most significant impact consequences. For that risk management is the best tool for assessment funds and resources. In addition, even if a particular management system has the most sophisticated models and methodologies to find optimum decisions for a particular operation, the overall optimum is always affected by other variables.
These problems and questions are addressed adequately in the concept of integrated auditing for management systems. In this concept, it is assumed that several types of management can be integrated within a risk management system which provides decision makers information to examine the impact of various alternative scenarios. In addition, the cost of implementing an integrated system is much less than the total cost of implementing several individual management systems.

3.6 Risk Elements of Management System

The *International Safety Management Code* (ISM) implemented firstly in 1998 to the vast majority of ships is a compulsory management system for proper safety ship management of all types' ships. In the ISM Code within the stated objectives set out and particularly in paragraph 1.2.2.2 of the ISM Code states, "Safety management objectives of the company should "establish safeguards against all identified risks". Although there is no further explicit reference to this general requirement in the remainder of the Code, risk assessment of one form or another is essential to compliance with most of its clauses.
It is important to recognize that the company is responsible for identifying the risks associated with its particular ships, operations and trade. According to ISM code it is no longer sufficient to rely on compliance with generic statutory and class requirements, and with general industry guidance. These should now be seen as a starting point for ensuring the safe operation of the ship.
The ISM Code does not specify any particular approach to the management of risk, and it is for the company to choose methods appropriate to its organizational structure, its ships and its trades. The methods may be more or less formal, but they must be systematic if assessment and response are to be complete and effective, and the entire exercise should be documented so as to provide evidence of the decision-making process.
The ISO 9001:2000 series of standards are a powerful tool for the application of the Quality Management System. It defines a quality management as a set of interrelated or interacting processes that achieve the quality policy and quality objectives.
The clause 1.2 states: 'All the requirements of this International Standard are generic and are intended to be applicable to all organizations, regardless of type, size, and product provided.' An approach to the development and implementation of the quality management system to the maritime management is widely used

considering shipping activities as services provided to clients who are ship owners and Charterers respectively.
An approach to the development and implementation of the quality management system consists of the following steps:
A. Determination of the needs and expectations of clients
B. Establishment of the quality policy and quality objectives
C. Determination of the processes and the necessary responsibilities
D. Determination of necessary resources
E. Establishment of methods to measure the effectiveness and the efficiency of each process
F. Application of these measures
G. Determining means of preventing non-conformities & eliminating their causes
H. Striving for continual improvement
The ISO 14001 series recently amended in the 2004 version of Environmental Management System Standards and supporting guidance is a powerful tool of internationally recognized standards that specify a model for creating and maintaining an Environmental Management System (EMS) in an organization. The ISO 14001 series includes guidance on mandatory EMS elements, and supporting activities that a company may wish to employ, such as Life Cycle Assessment, Environmental Labelling, and Environmental Auditing. The Standards for Environmental Management according to the ISO 14001 is tool for an organization to keep aware of the interactions that its products and activities have with the environment and to achieve and continuously improve a desired level of environmental performance. An approach to the development and implementation of the environmental management system to the maritime management is used considering shipping and shipboard activities interaction with the environment in order to achieve environmental goals for protection and prevention of pollution in balance with socio-economic needs. The standard is applicable to an organisation that wishes to:

A. Implement, maintain and improve an environmental management system.
B. Assure itself for the conformance with its stated environmental policy.
C. Demonstrate conformance.
D. Seek certification of its environmental management system by an approved third party.
E. Make self determination and self declaration of conformance.

The OHSAS 18001:1999 series is not yet an international standard but specification gives requirements for an occupational health and safety management system, to enable an organisation to control its OH&S risks and improve its performance. This OHSAS 18001 series specification is applicable to any organisation that wishes to:

A. Establish an OH&S management system to eliminate or minimize risk to employees and other interested parties who maybe exposed to OH&S risks associated with its activities;
B. Implement, maintain and continually improve an OH&S management system
C. Assure itself of its conformance with its stated OH&S policy
D. Demonstrate such conformance to others;
E. Seek certification registration of its OH&S management system by an external organisation;

F. Or make self determination and declaration of its conformance with OHSAS specification

An approach to the development and implementation of the OHSAS management system to the maritime management is not yet widely implemented since OHSAS mainly focused to the internal organisation's activities since ISM also deals with safety of crew. From that perception OHSAS either should be incorporated to ISM or should be implemented separately.

In the previous sections we have mentioned analytically the specific- issue risk management and the steps for proper handling. It was also mentioned the establishment of the corporate risk management which is a systematic risk management system in a maritime company. Risk assessment provides the information upon which risk managers make their decisions. This information is comprised of data and interpretations thereof. Environmental Management requires that risk managers make decisions relating to environmental risks. At least three types of information are required to enable risk managers to address safety, quality and environmental risks:

(i) data regarding the organization's safety, quality and environmental performance and relevant issues;
(ii) criteria upon which to base safety, quality and environmental risk based decisions, and
(iii) Framework in which to make risk-based decisions.

The fields of environmental assessment, risk assessment and risk management have much to contribute to this information base. The implementation of risk assessment and risk management in implementing an SMS, QMS, OHSMS and EMS according to International Safety Management Code ISM, ISO 9001: 2000, ISO 14001:2004, OHSAS 18001:1999, and determined that the above standards establishes the following requirements with significant relationships to risk assessment and risk management:

- An organization must develop and the Company's top management shall establish, document and maintain pertinent policy (ies) for occupational health, safety, protection of the environment and quality in accordance with and appropriate with the purpose(s) of the management system. The organization must determine the duty of care in its policy statement and a part of this duty is to undertake a formal and documented process of hazard identification and risk assessment of all its undertakings and activities (ISM 2.2, ISO 9001 4.1, ISO 14001 4.1, OHSAS 18001 4.1).
- An organization must develop and the Company's top management shall define the Company's policy (ies) and ensure that, within the defined scope of its management system, it provides for safe practices in ship operations and a safe working environment, includes a commitment to continual improvement, and prevention of pollution, establishes safeguards against all identified risks (ISM 1.2.2, ISO 9001 5.1, ISO 14001 4.2, OHSAS 18001 4.2)).
- An organization must develop and the Company's top management shall ensure that the Quality policy is appropriate to the purpose of the organization focusing customer's needs. Is reviewed for continuing

suitability for determination of requirements related to the product and includes a commitment to comply with requirements and continually improve the effectiveness of the quality management system; and provides a framework for establishing and reviewing requirements related to the product (ISO 9001 5.2).

- The Company's organizational goals and expectations shall be monitored, measured, reviewed and analyzed to ensure that the processes are implemented effectively for the requirements related to the product (ISO 9001 7.2.1 & 7.2.2).
- An organization must develop and maintain a procedure to identify the "environmental aspects" of its operations. This includes its activities, products and services, and those of other organizations over which it can be expected to have influence. The organization must determine those environmental aspects which have or can have "significant" impacts on the environment. The organization is also to ensure that the aspects related to these significant impacts are considered in setting its environmental objectives. Risk analysis techniques can form an important part of the procedure used to identify and evaluate a company's environmental aspects (ISO 14001 4.3.1).
- An organization must develop and work towards occupational health and safety quality and environmental objectives and targets, as relevant to each function and level within the organization. The quantitative results of risk analysis can help to establish objectives and measurable targets(ISM 1.2.3, ISO 9001 5.4.1, ISO 14001 4.3.3, OHSAS 18001 4.3.3).
- The organization shall establish and maintain procedures for the ongoing identification of hazards, the assessment of risks, and the implementation of necessary control measures. These shall include routine and non-routine activities; activities of all personnel having access to the workplace (including subcontractors and visitors) facilities at the workplace, whether provided by the organization or others. The organization shall ensure that the results of these assessments and the effects of these controls are considered when setting its OHSAS objectives (OHSAS 4.3.1).
- The organization must perform a periodic management review of its management system implemented in accordance with documented procedures, to address the possible need for changes to policy, objectives and other elements of its management system. Having concrete information to consider, such as that provided by risk analysis greatly assists the management review function(ISM 12.2, ISO 9001 5.1, 5.6, 8.5.1, ISO 14001 4.6, OHSAS 4.6).

The potential contribution of risk management to ISM and ISO 9001, ISO 14001 and OHSAS 18001 management systems is significant. It was referred above how risk analysis, assessment and management incorporated to the management systems and in which extend can contribute to the overall management system. It is also very important to determine basic commonalities between risk management and Management System ISM and ISO 9001, ISO 14001 and OHSAS 18001 elements. These are considered with respect to the seven elements of successful corporate risk management,

presented previously. Additionally the decision making process regarding safety, quality and environmental matters is to be undertaken in the context of an organization's overall priorities and policy taking into account relevant legal and regulatory requirements, financial, operational and business requirements and the views of interested parties.

- Commitment of the Top management to an integrated management system with a set of values which are enrolled in the respective policies. Senior level commitment is one of the basic tenets of integrated management system and all relative ISO standards. Only with this commitment can a comprehensive system be developed, implemented and live over time within the organization. The 'value set' is important to be set by top management in the policy which is designed to be mobilized into specific programs and procedures.
- Priority setting is also important based on the analysis of risks supported by data and a skilled staff. The potential for risk analysis to contribute to information generation and priority setting was presented above. This priority setting occurs during the initial review and planning of the integrated management system and is updated on a reoccurring schedule as part of Management Review and continual improvement. ISM and relative ISO standards also establish requirements for appropriate training and communications, so that crew and staff are capable of performing what they are responsible within their duties.
- Most important relation to standards and risk management is the intention to audit and review management system, often by internal skilled people or external consultants. Both internal and third party audits are required under ISM and ISO standards as well as risk management. Is important in internal audits to ensure that those auditing a management system's element do not participate or have responsibility within the organization.
- Communications, feedback and corrective action based on implementing and monitoring management system. Effective internal communications regarding core elements, issues and procedures must be established under ISM and ISO standards. Integrated management system also requires the establishment of procedures for identifying non-conformances, and implementing corrective and preventative measures. Review of organizational and management structure when monitoring and data indicate that there is a need for improvement. Preventative measures and organizational changes identified through ongoing monitoring and Management Review will be developed and implemented in accordance with objectives and programmes in conformance with company's policy.
- Policies for management of change that assign a higher level of care for potentially more significant changes. The Integrated Management system structure and programs, and the procedures for establishing objectives and targets are to be keyed to the significance of an organization's aspects. These elements must be defensible to an external or internal auditor.
- The ISM and ISO requirements for training, awareness and competence of staff, and the consideration of the views of interested parties, are consistent with risk management requirements.

In addition to addressing these elements of successful corporate risk management, ISM and ISO standards incorporate document control and record keeping functions designed to ensure that the system is functioning, and providing the ability to prove it. Further, in addition to generating relevant information and making appropriate priorities, ISM and ISO requires that specific programs be implemented to deliver them. These elements would support corporate risk management as well. Major accidents emanated from that have barely harm people's confidence to the effectiveness and performance of maritime transportation. Additionally losses of customers, contracts, financial growth and good will are also important and can also erode profits. Integrated management system establishes a framework to ensure that risk management tools are used. Inasmuch as they are established as elements of the ISM and ISO standards, a third party auditor requires that the tools be understood and used, and that their effectiveness be monitored. In maritime management companies there are various concerns to manage, generally including operational activities, finances, human resources, quality of provided services, charterers' relations, health and safety, environmental interactions, and possibly others. Inasmuch as there is uncertainty, there can be risk involved in all of the aspects of integrated management. The fundamental consideration in linking management systems and risk management must be the nature of the link. Any given business must focus on a management system consistent with its business needs and exposure. While looking to increase efficiency by integrating management functions, the appropriate contribution or position of each management model must be established in relation to the level of the risk exposure. In the situation discussed in this project, the first area to clarify is whether risk management will be contributing to the ISM and ISO integrated management system. There are significant commonalities between risk management and Integrated Management Systems. There are a number of ways in which the requirements of ISM and ISO standards can establish within an organization the conditions necessary for effective risk management and the techniques of risk management can contribute to addressing specific activities commonly encountered in implementing an Integrated Management system according to ISM and ISO standards. If a maritime company is implementing ISM in combination with QMS, EMS and OHMS as a model for Integrated management system and is attracted by the potential benefits of risk management it should first determine what it expects to achieve by assessing each set of management activities and how that relates to overall corporate success. Then it should consider the potential linkages and determine how the risk elements should be integrated in its own management system. The following are the main risk based elements RBE of ISM code and ISO 9001:2000, ISO 14001:2004, OHSAS 18001:1999.

- **Policy orientation**
- **Planning**
- **Implementation and Operation**
- **Checking and corrective action**
- **Management review**

CONTINUAL IMPROVEMENT
A. NATURE AND SCOPE OF DECISION
B. MANAGEMENT SYSTEM
C. STAKEHOLDERS ANALYSIS
D. RISK SCENARIOS
E. RISK SCENARIOS
F. PERSONNEL RECRUITMENT
G. OPERATIONS AND NAVIGATION
H. HAZARD IDENTIFICATION
I. CARGO OPERATIONS
J. BALLAST OPERATIONS
K. MOORING OPERATIONS
L. RISK ANALYSIS
M. PLANNED MAINTENANCE
N. RISK ASSESSMENT AND ESTIMATION
O. RISK MANAGEMENT AND EVALUATION
P. ACCIDENT & INCIDENT INVESTIGATION
Q. SAFETY MANAGEMENT
R. ENVIRONMENTAL MANAGEMENT
S. RISK PREPAREDNESS AND PLANNING
T. QUALITY MANAGEMENT
U. RISK SELF ASSESSMENT & AUDITING

Table 3.16 Risk based Management system Core Elements

3.7 Strengths weaknesses opportunities and threats

The IASMAR project which is an integrated risk auditing system within the elements of Marine Health, Safety, Quality and Environmental Management and has been developed with the objective of improving SQEOH performance in the management and operation of ships. Its elements have been stated in general terms in order to have application to a wide variety of ship operations and styles. The strength of this project emanated mainly from the ability to combine risk management to the implementation of existed sound management systems based in the requirements of the International Standards. It is a complex and specialized work requiring innovative study but the assumptions and pre assignments of variables which are compared for values proved to have relation with the prediction of incidents related to SQEOH management systems are based in the existed implemented and already created experience management systems in maritime management.

This project also, since there is not yet any decision for common approach on risk assessment or risk management provides the maritime industry with a model for implementation of all management systems in a risk based approach concerned with the maritime activities and corporate risk management. This project is intended to be a useful tool for the use of maritime companies operating all types of ships. The project provides information, specifications, and other standards associated with them, and contain valuable information and guidance useful in understanding the fundamentals and implementation of viable management systems following the risk management approach. Though this

project has been developed principally as a risk based management system model for shipboard operations related to SEPOH the need also for financial, chartering and quality concerns are also addressed. Beside chartering, financial and quality issues focuses principally upon enhancing customer satisfaction and ensuring that customer requirements for contracts are fulfilled, additional focus made on threats considered for the reliability and documentation of contractual parties and financial objectives that have a significant positive impact on achieving goals and objectives in the other critical areas the integration of which is a unique up to now approach since occupational health, safety and environmental management was the only areas of research in risk management of maritime industry up to now . The financial, chartering and quality requirements of this project provide prescriptions that by their optimization will enhance also a SQEOH management system's effectiveness.

The strengths of the IASMAR approach are:

It is easy to apply and requires few specialist skills, and for this reason it is attractive to many project teams.

Decision judgments which are required by the insurance or authorities on justification of likelihood and consequence properly recorded and the basis for risk decisions will not be lost. The decision judgements are consistent among different team members and stakeholders, whom critical information could be used to decide and achieve whether qualitative or quantitative definitions should be used. It allows risks to people, property, environment and business to be treated consistently. It allows hazards to be ranked in priority order for risk reduction effort. The performance of a risk auditing system is appropriate for almost all maritime hazards and in particular for the maritime activity which is well established with good operational experience and a good track record of safe operations. Can commence and develop continuous improvement in the company's management system onboard and ashore by defining the weak areas needed improvement. The lack of standardization have caused confusion that why risk ranking approach is probably the most accurate approach used for risk assessment in marine activities, as they are appropriate for people new to risk assessment, being straightforward to apply and easy to understand.

There are several limitations, including difficulties in dealing with multiple differing outcomes, consistency in application, transparency of categorization decisions, and dealing with novel hazards. The weak point is that quantification of data based in subjective opinions for the categories, likelihood and severity impact including top event and control options. This could be managed by enhancement of staff's knowledge in risk management and record keeping of the existed cases. Risk management is based in the continue improvement principle and always such effort should be made by going around the loop of systems elements and utilizing properly feedback. However, there are also other several problems with this approach, which are less apparent:

Where multiple outcomes are possible (e.g. a fall on a slippery deck – consequence can range from nothing to a broken neck), it can be difficult to select the "correct" consequence for the risk categorization. Many specialists suggest using the more pessimistic outcome and not a very rare worst case nor the most likely trivial outcome.

Additionally weak point is that the risk approach looks at hazards "one at a time" rather than in accumulation, whereas risk decisions should really be based on the

total risk of an activity. Potentially many smaller risks can accumulate into an undesirably high total risk, but each smaller one on its own might not warrant risk reduction. As a consequence, the assessor has the potential to underestimate total risk by ignoring accumulation.
The risk ranking does not have a formal linkage to the tolerability of risk framework. A key task for maritime safety cases is to ensure that the risk evaluation and ranking will conform to the ALARP approach, and if this is not the case then the definitions should be altered appropriately. A good test is to verify that borderline decisions on risk reduction as determined from the ranking match current good maritime practice.
The project's main opportunity is the strong demand by maritime companies and associated parties, such as Hull and Machinery insurances, P+I s', classification societies, flag administrations, port authorities and port state control, for a practical and systematic risk management system followed by shipping companies which will improve further the compulsory implemented international safety management and its objectives for identification of risks.
Additional opportunity is the possibility of acquiring professional rights in creating a risk management system for the ship management companies and guidance for proper training in order to create and enhance risk proactive culture.
The major threat by adopting and formally implementing IASMAR is that the company is officially exposed in case of an incident to authorities and parties have contradicted interests and liabilities with them. This could lead for a shipping company to carry always the burden of blame for everything and to be actually uncovered by the insurance companies. In that case the official implementation needs care to the reporting forms officially submitted to fulfill requirements. Public concern in modern societies is becoming increasingly aware that maritime industry is not only bear benefits of cheap transportation but also created large scale accidents resulted cost not only in monetary terms but also in huge environmental damage, increased illness, injury and loss of lives. Application of "duty of care" principle consisted of awareness and understanding in combination with systematic assessment and auditing and review of current level of risk management intended to become mandatory soon and therefore IASMAR risk management will be used to adequately address prudent management and systematic handling. The value of my project has well recognized among participants and significant interest exists in implementation by major shipping companies which also are widely exposed in liabilities due to the type of ships and nature of cargo transported. The idea of conditional probability identified and quantified by IASMAR auditing process is related to competence of employees onboard and ashore and selection of information that could extend in procedural, human and technical parts and services following cost benefit analysis for optimal distribution of resources which also inspire seriousness and professional handling to the employees and subcontractors.
The IASMAR project is designed to facilitate a progressive approach to a fully integrated management system of safety, quality and environmental concerns. It is not a risk management manual and should not be considered like that. Is also based in the continuous improvement principles and findings should not considered guidance for improvement to any Ship Management Company since data and ranking emanated from the particular company's application results.

CHAPTER FOUR: THE RESEARCH AND METHODOLOGY

4.1 The research methodology

The IASMAR is a work based project used a range of methods to approach the task outlined in aims and objectives. The core element of the project developed with the assistance of my colleagues and participants, using the knowledge that I had developed from close reading of the risk management literature and by exploring ways to apply that information in maritime management. Practically I have tried to materialize risk management concepts and turn theory in working practice. The driving force behind the project was the creative relationship with the participants the majority of whom had great experience and knowledge in safety and environmental issues, and my desire to enhance this knowledge in action and on action. Monitoring procedures and assessments in various activities and cases discussed and managed successfully as a part of normal working routine, and benefits proved the significance of the project. Time was allocated every two weeks to discuss with available participants the ideas and conclusions as well as the actual cases rose in action during daily operation including the risk preventing strategies for different owned types of ships. This was seen as a priority in order to make participants aware of a risk management system for which they had limited knowledge for proper implementation and available time- space created in busy diaries to allow this to take place. Finally after long period of doubtful discussions regarding subjectivity and availability of data and scenarios almost all agreed that the use my project as a tool for management of risk was very successful and efficient in action. Activity centered instead of hazard or event centered philosophy was the major difference and the new conceptual approach of my study. Self discipline, commitment and personal drive in a progressive environment of professional colleagues assisted me in the successful completion of my project which is employing action research for retrieving information at first regarding awareness and implementation of risk management in day to day operation of shipping activities and then supplemented by 3 (three) surveys in which two research methods were used. The current condition under which there is not yet any decision for common approach framework on neither risk assessment nor risk management which could adhere to the above mentioned management systems made the trial application of IASMAR project a unique approach that is ideal for professionals due to its distinctive advantages with the most important to be the accreditation of previous maritime experience and the work based lessons learnt in action. IASMAR is the only integrated program which combines implemented management systems with risk management and self assessment and can easily be implemented in the two stages of corporate and specific activity adopted in my project. The sequence of awareness, knowledge, understanding by the first survey No1, list of activities, hazards, aspects, impacts, acting areas, types of incidents, causation chain and maritime risk assessment by the survey no 2 case studies and risk management, risk auditing, critical core elements, criteria of interrelation, self assessment, ranking management areas for predicting weak risk areas by surveys no3 provides a useful tool which can commence and

develop substantial organizational improvement and its success promotes risk management in the industry for further implementation. The specific methodology used for this research is presented below and it covers questionnaire, collection and analysis of data and development of risk management model. The Survey 1 made by the use of a questionnaire issued to gain feedback on awareness of risk management system, the availability and willingness for implementation as well as common metrics and procedures. The Survey 1 aimed to be an international survey of maritime companies and other relative stakeholders in order to collect evidences and provide capabilities of risk framework implementation. Additionally this survey endeavored to establish to what extend the implementations of maritime risk management framework is workable with success within the scope of the implemented Management systems in shipping industry. Survey No 2 was a series of case studies for all 8 types of ships which was arranged to obtain participant's view concerning probability of a top event in combination with risk estimation by likelihood and severity level in shipping activities as well as the level of confidence participants had for their estimations. In Survey No 2 which is work based the risk assessment of actual and specific issue activities analyzed for the probability of a top event in relation with causation chain and the correlation between risk index and event probability identified and a prediction model on events per causes established. The Survey No 3 was a series of auditing questionnaires of critical core elements in order to gain feedback on level of competence of risk management in the implemented management system by identifying and ranking the weak areas seems to be more risk exposed needed further improvement. The auditing of the risk based management system of safety, quality and environmental protection in relation with assessment of interrelation of potential consequences to property, human and environment is a model which assesses the weak points of the implemented system and potential areas of incidents with highest risk factor and predicts in a way the probability of a top event in a specific area of management.

Extensive literature review was contacted to investigate existing research that is significant to this project. This effort looked into research topics including management systems as per ISM and ISO, Formal Safety Assessment, RBDMP, risk assessment, risk management, auditing and class rules and regulations. Critical issues concerning the application of auditing into implemented maritime risk based management system were identified. During literature review investigated first the parameters contributing to risk estimation and other available references to methods and techniques of risk assessment as well as metrics of parameters involved in risk management. Existing research topics related to risk and auditing of safety and environmental issues were examined to identify the critical core elements for applying IASMAR ranking score and identify risk weak areas. The research proceeded with the use of available statistical analysis methods to develop correlation models and finally to materialize a prediction model of events related to weak areas needed further improvement. The main philosophy behind the risk auditing of maritime management system in a corporate or activity level is to take the common aspects of different management systems and combine them by using an evaluation ranking method by which the continuous improvement and objectives will be successfully achieved.

The common aspects combined from the elements of management systems can be outlined as follows:

1. Analysis of interrelation of risk level with safety, quality and environmental issues.
2. An auditing collected data ACD.
3. Analysis of consequence and severity models.
4. Correlation models.
5. Graphical presentation

Among these aspects, the most important is the auditing collected database including the weight attribute and department's data for each type of core element.

The results of the project conducted by the author and participants within the maritime community show that IASMAR is a very effective auditing tool of an integrated management system.

At Administrative Level	*At Operational Level*	*At Technical Level*
1) Summarizes policy and objectives	**1) Prioritizes operational decisions**	**1)Prioritizes maintenance decisions**
2) Summarizes programmes and legal requirements	**2)Analyzes cost effectiveness of operational decisions**	**2)Analyzes performance of machinery and equipments**
3)Addresses responsibilities and authorities	**3)Identifies hazards of operations**	**3)Identifies breakdown consequences**
4) Establishes needs	**4)Prioritizes control measures Programmes, schedule and actions**	**4)Prioritizes purchasing of spares and stores of machinery**
5) Establishes overall communication	**5)Makes information readily available**	**5)Makes information of all equipments readily available**
6) Assists with budget estimates	**6)Controls costs**	**6) Controls cost**

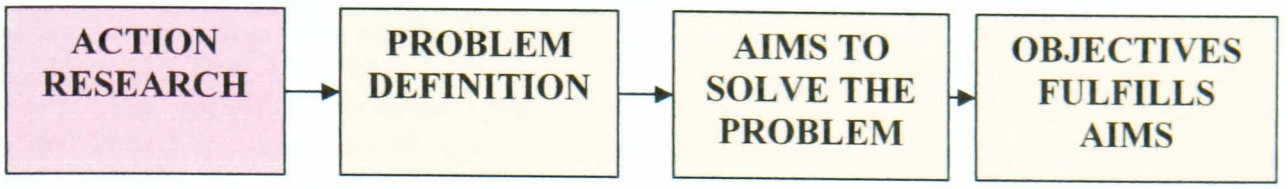
Table 4.1 shows the aims of implementing a risk based integrated maritime management system in which auditing system directed to accomplish at the three levels of a company.

Additional process of the retrieved auditing collected data is take place by a multivariable analysis of contribution of risk based management system to potential losses of property, human and environment as a predicting tool. My project is a work based programme advancing my personal and organizational learning in Risk Based Management of Safety, Quality, Occupational health and Environmental protection weighted and verified by auditing results.

4.2 Action Research

The initial approach of this work based project has been action research and action learning. Unlike conventional research, which requires proving objectivity and attempts to understand cases and situations, the stance we adopted was from action research perspective. In action research we have tried to identify the problem and take action to solve and improve it. The process of action research parts of four elements: planning, acting, observing and reflecting. This approach considered suitable for the first part of my project as it focuses on the

researcher as worker seeking to improve aspects on their own and colleagues' practices. The process of action research will typically involve the following:



Identify the problem of difficulty

Managing risks in shipping and shipboard activities through the auditing is a main part of the management development process in which continuous improvement accomplished. Significant incidents and their consequences can be avoided if variables and management system's elements evaluated and treated properly as early as possible. The change in culture for implemented management systems is attempted by implementing risk management approach in an activities centered dynamic system incorporated in the existing management system plan basically ISM and then ISO 9001, ISO 14001, OHSAS 18001. The lack of an easy assessment way to treat risks by a systematic way during daily operations and common metrics for risks in maritime management was in great need by managers and stake holders. For identifying and address the potential problems a survey established with participants from 50 maritime companies involved in informative questionnaire addressing any potential issue in risk methodology of various ships' types. The research of this area was qualitative and participative. The problem with which the research starts and aims to take action to improve the situation is:

- ***If and how risk management could be implemented formally in Maritime Companies as a proactive risk based management approach comprising technical, financial as well as operational aspects in specific activity level but also in a corporate level?***
- ***If and how this corporate risk management system could be combined with existing management systems in the basis of common core elements.***
- ***If and how the maritime companies could rank by a systematic auditing system their management systems based on risk assessment and prioritization of control measures in order to improve their effectiveness and reduce the probability and severity of a potential unwanted event.***
- ***If and how additional process of the retrieved auditing collected data can be used by a multivariable analysis of contribution of risk based management system to predict potential losses of property, human and environment.***
- ***Finally what is the gap analysis between the existing situation and the actual one and what is the actual time schedule for effective implementation.***

Based on the above questions I have developed the conceptual design of the aims and the objectives should be accomplished. Additionally two conditions for project's success were discussed and defined.

Condition 1: The IASMAR ranking score indicates the current level of risk index and corresponds to risk performance. It means that IASMAR scores correlated to measure the risk management success in relation with shipping activities and implemented SQEOH management system.
Condition 2: The IASMAR is a reliable indicator of potential maritime risk factors and IASMAR scores that can be used to quantify risk impact on implemented management system weak areas outcomes based on auditing collected data from actual audits.

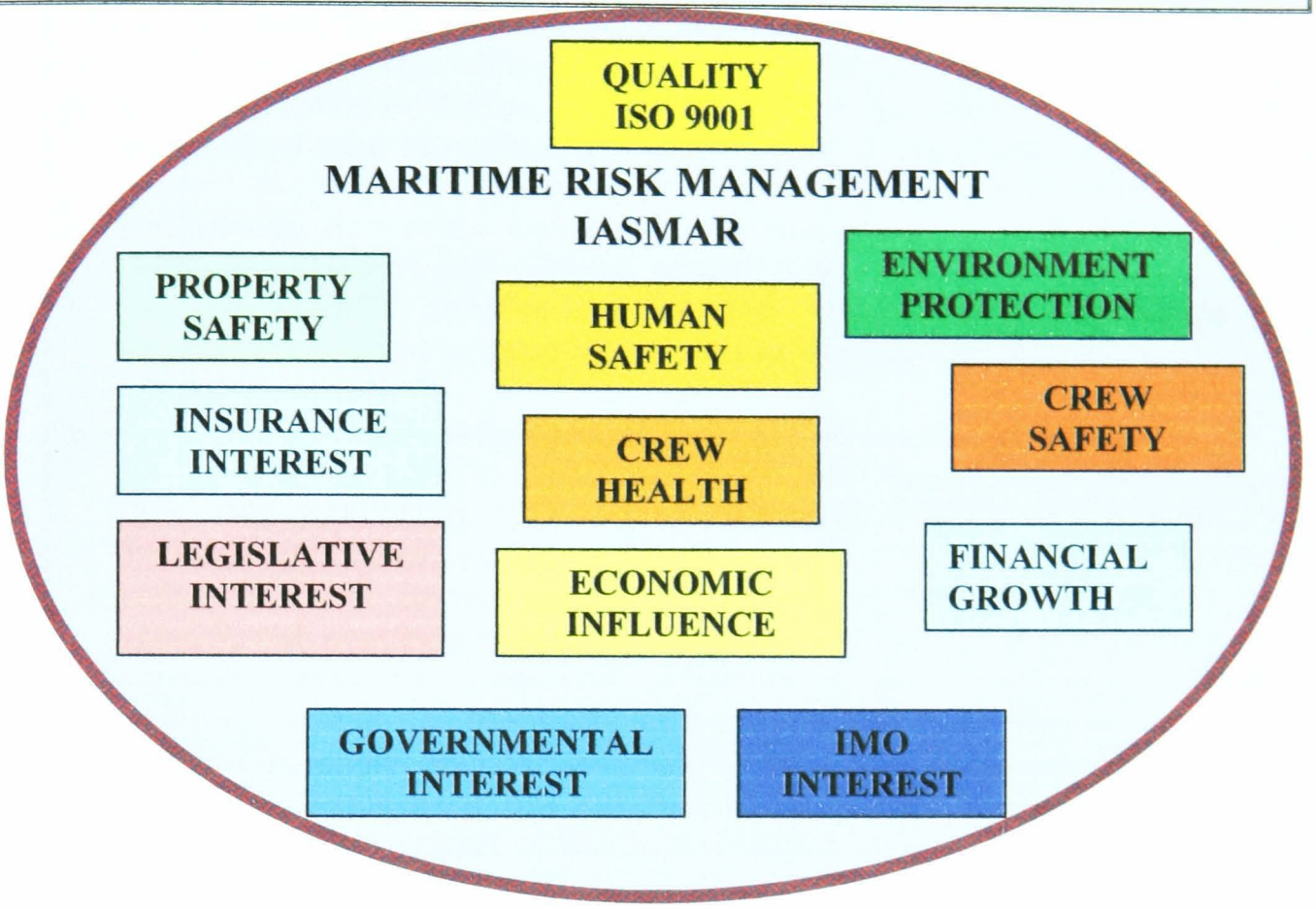


Table 4.2 IASMAR associated elements

Following I have issued clear and specific ***aims on my research***:

1. **To design a risk ranking and auditing system and to develop a systematic risk management approach based on the IASMAR.**
2. **To establish a methodology and database for activities and corporate risk management research.**
3. **To identify and prioritize the level of awareness and ability of implementation of risk elements steps and impact of ranked specific activities and core elements of the IASMAR.**
4. **To provide with a report and further validate the IASMAR through testing by measuring the level of risk in specific activities and corporate risk management and define the degree of actual management's success.**
5. **To develop my own professional capacity to an advanced level of expertise and contribute substantial knowledge among interested parties in maritime industry.**

In order the above presented aims to be accomplished the following ***objectives should be fulfilled***:

- **To establish a number of 3 surveys to assess and define common awareness and knowledge about the risk management phases and to relate safety, quality, environmental and occupational health management elements to risk level and impact on shipping activities and management by analysis of the collected participant's data.**
- **To get feedback on common understanding for the methods, parameters and criteria used by risk approaches to safety, quality and environmental assessment that can be applied to shipping.**
- **To establish a list with preliminary standard database for shipping and shipboard activities which should be assessed in combination with associated hazards and tasks defined by the participants.**
- **Collect the different participants' viewpoints on risk possibility and probability of events by assessing risk index and success index levels for events by likelihood, severity, actuality and necessity.**
- **To investigate satisfaction of the results and the ease of implementation in combination with implemented ship management system.**
- **Enhance the knowledge about the core elements of Safety, Quality, Environmental and Occupational health Management Systems as per ISM, ISO 9001:2000, ISO 14001: 2004 and OHSAS 18001:2000 and Risk Management and correlate these by a model in order to predict risk level under certain values of IASMAR ranking scores values.**
- **Identify the practice to respond to daily operations and activities and evaluate weak areas relevant to safety, quality occupational health and environmental elements to consequences in property, human and environment and demonstrate continuous improvement.**
- **Finally to implement the surveys in participant's company agreed and assess the impact of the implementation.**

Identify and implement the change to improve the situation

The project's research will endeavour to implement change in the ship management system already existed either in the mandatory form of ISM, or in the voluntarily implemented QMS, EMS, OHSMS. The change will be the introduction of risk management steps and elements in a systematic way for risk analysis, assessment and management of the ship board and shipping activities. To identify and implement the change I defined and analyse the risk management sequential steps in risk management for specific activity and corporate level based in the literature review. The research family which is used is *qualitative* in first stage for the part investigating the qualitative characteristics of the risk management implementation. It is designed to focus on knowledge and experience of participants in risk management issues. Analysis of qualitative data, provided in the results, is partially quantified by counting the options in replies of the questions submitted in the Survey 1 and case studies in Survey 2. In my project's first stage the decisions are focussed on the richness and depth of the risk management's common awareness and knowledge as per aims and objectives presented above. During the materialisation of my project I have started by choosing purely qualitative design in the first issued questionnaire but

later I decided to include quantifiable elements for quantitative analyses and common metrics. That's why the Surveys 1 and 2 considered finally to follow quantitative approach and so called Surveys. The research family which is used in the second stage is *quantitative* for the part of auditing the particular management and risk elements in different departments with the resulted collection and analysis of scores in numeric form. This stage tends to emphasize relatively large scale and sets of data from participants dully analysed by a statistical proposed method.

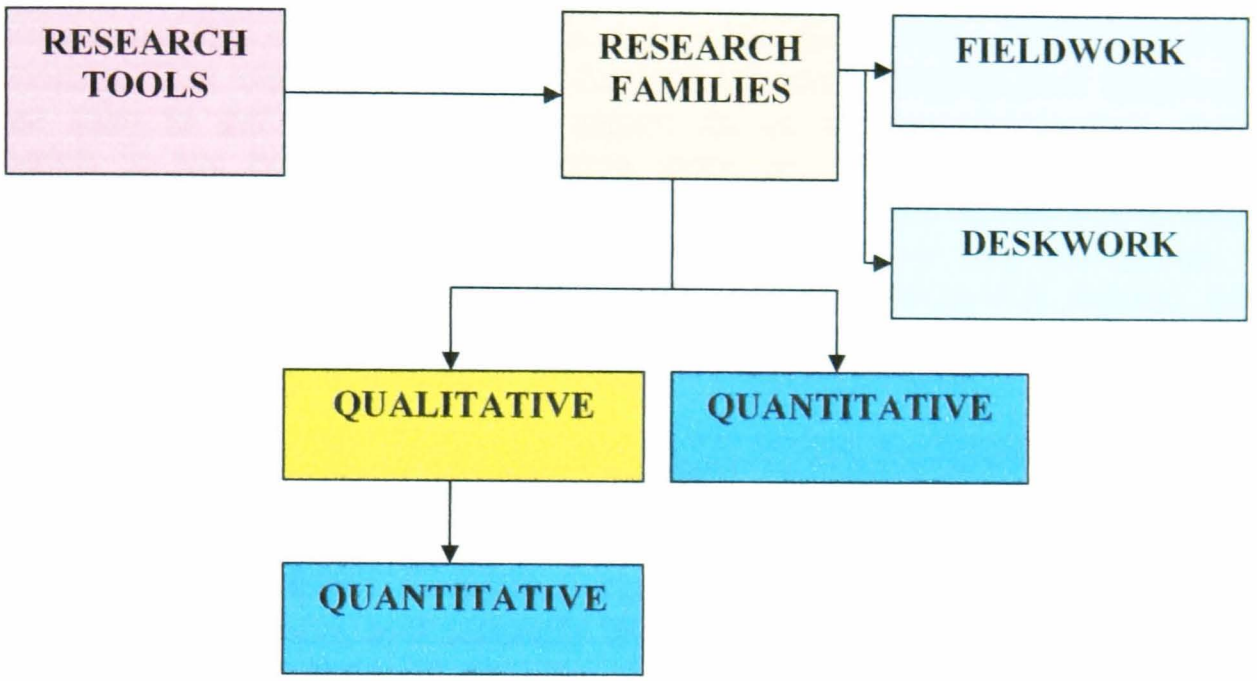


Table 4.3 Research sequence

The Research family should be considered also as a combination of *fieldwork* and *deskwork*. Firstly research for my work based project was my own working environment and also involved visits to other participating companies and handed out questionnaires to participants and had meetings to explain and observe conclusions. Additionally a major part of the research collected and processed in my company together with literature researches in the internet.

Testing an evaluation to determine impact of change

From the Surveys the results outlined in the next chapter 5 have shaped the research and focused the project participants in its efforts. Due to the high qualification of the participants the results were perfect fit for the maritime industry. As a result of the questionnaire of the Survey 1 a wider and systematic perception of maritime risk management established and common metrics issued for the execution of case studies in Survey No 2. All risk management steps and metrics have been explained and discussed analytically during the Survey No 1 to the participants, who have customised many of them in their day to day operational activities, where appropriate. It was also succeeded to encompass the views of all those participants involved in the work based project getting risk management solutions in existing difficult cases. Action research is collaborative

by nature. That's why I have tried to involve as many as participants on their own group and organisation.
In the beginning I had led the research by myself and a group of my close colleagues in the company and friends participants. Their honest participation and assistance helped me to develop a most complicate questionnaire than initially considered since I was reluctant to issue a piece of more than 20 pages. The informative explanatory supplement I have embodied in the questions resulted finally 85 pages it's of course difficult to fulfilled and followed patiently but participants consider it necessary since a great part of risk management process was confused to their minds. Most participants found very interesting and many red this over their free time and weekends and found very useful and interesting. This encourages them to direct their own change in their companies rather than to get an outside risk expert as an outsourcing service. Action research in my project was educative since an integrated knowledge and awareness received during the research. It was problem focused and future oriented and involved a change intervention. Its aims and objectives as presented above had improvement directions and participative nature. Also invoked an iterative process in which research, action and evaluation were interlinked by drawing conclusions and communicating findings.

4.3 Soft System Methodology

In my project at the second stage the research approach of *Soft Systems Methodology* applied to achieve organisational changes which are both systematically desirable and culturally feasible. This methodology provided the differences between the real situation verified by the Survey's No 3 Auditing Collected Data, "What is" verified by ACD, and how things might work, "what ought to be", as per implemented management system elements ISM and ISO standards of Maritime Management. This methodology was considered appropriate since soft human activity to analysis at the level of system. The Survey No 3 derived in two surveys and by using SSM which includes many of the key elements of action research but also places more emphasis on analyzing the problem and possible solutions before any action taken. In the Survey no 3 the research employed soft system methodology because it favoured an organizational learning approach over the problem solving approach. The conventional definition of the problem to be solved is a perceived discrepancy between an actual state and a desired state. By implementing SSM in Survey No 3 it does not automatically assume, but it moves from verifying the present level of a complex risk management elements system involving audited people, to take action which will effect in continuous improvement and finally in the improvement of effectively managing risks in maritime industry. The conceptual model of Soft Systems Methodology implemented in my auditing Survey No 3 brings the process for improving the existing management system and the risk based approach in the decision making in the sense that it will yield insight into the situation and assess the existing level based on the hypothesis that the articulation of the structure of the auditing elements represent what ought to be in order to conform with standards of the implemented system.

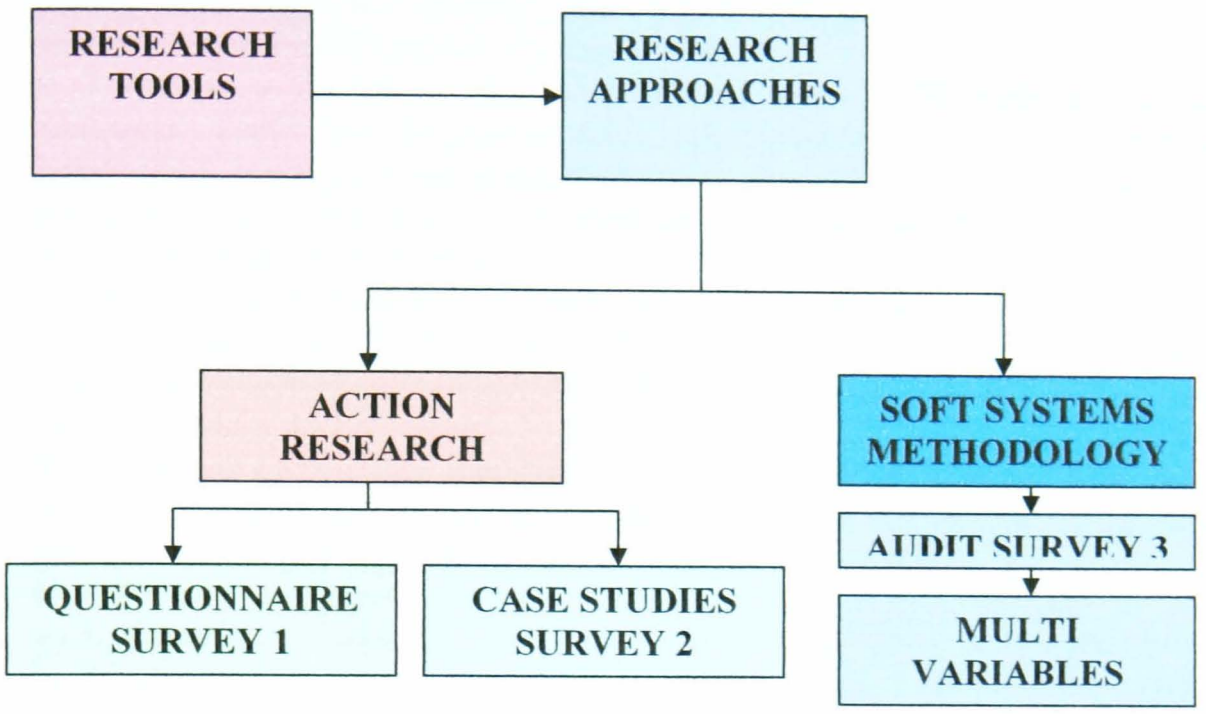


Table 4.4 Research Tools

So the variables of the system which are presented analytically below are the structured elements of the implemented management system which a company should comply with in order to demonstrate conformance with ISM or ISO standards. To ensure that the research approach is complete and adequate, a compilation of features will be applied to the formal system model which is required to comprise a system capable of purposeful activity. These features are:

1. ***The mission of continuous improvement which is the corner stone of any standardized management system. By using soft systems this could mean the pursuance for continuous improvement which is never achieved.***
2. ***A measure of performance which succeeded by the ranking of the auditing elements and the comparison of the minimum standard of the management system needed to demonstrate conformance with ISM or ISO standards where implemented. The iterative process of ranking elements in correlation with company's departments provides evidence of comparison and failures in pursuing programmes or trying to achieve objectives.***
3. ***A decision making process which widely analyzed in my project in terms of a role of a designated person for decision making.***
4. ***Components and elements of the management system audited which are themselves partially systems which scored and audited separately having same priorities as the integrated management system which they belong. These components are ranked separately to urge attention to the weak areas needed prioritization for improvement which also contributing to the assessment of conformance of the overall system which also assessed as a part of the risk based integrated management system.***
5. ***There is a high degree of connectivity and interaction between the components most of which are common core elements in the management systems with different scope and direction i.e. ISM for***

safety, ISO 9001 for quality, ISO 14001 for environmental, OHSAS for occupational health and personal safety.
6. There is a common shipping environment with which the system interacts and the implemented management systems created an integrated management system having common policy, objectives and programmes which also interfering the same environment under the aim of continuous improvement.
7. There is a physical boundary of ship itself separating the maritime management system from the shipping environment where it interacts defining the areas within which the decisions are taken and the power to cause actions to be taken.
8. There are resources physical and knowledge which are responsibility of the management as per all standards which are at the disposal of the decision taking process.
9. The management system which evaluated and ranked has a self guarantee of continuity and has a degree of long term stability. This achieved by the routine auditing and inspection of various authorities and for which non conformances identified and corrected so even after some degree of disturbance will incurred by internal or external reasons, the system can easily by using preventive corrective actions in verified non conformances, can recover stability and conformance according.

The model of the auditing system of core elements and subsystems has created in the most representative manner questions of verifying status of each elements and subsystem. These questions addressed indicatively to the following critical departments heads relevant to company's organisation.

1. Managing Director
2. Operations Manager
3. Technical Manager
4. Chartering Manager
5. Purchasing Manager
6. Financial Manager
7. Claims Manager
8. DPA / MR

The compliance with the inquiry is measured by implementing a 3 stage reply to provide information for conformity and compliance with the existing standards.

Rank 1: below average
Rank 2: average
Rank 3: above average

The ranking score added and the Max score determined in the basis of 24 points and 480 points in total per element. Min score is considered 8 points in each item and min 160 points for each element. Beside that the areas of below average should be marked for further investigation. This comparison stage will throw up discrepancies between the real world situation and the conceptual model

presented above. This will generate two kinds of outcome: first the reassessment of the system, procedures and documentation by giving attention to the weak areas needed improvement and measure the efficiency of the amendments made, and secondly, to focus on the system and propose actions which will improve system's credibility and impose necessary changes.
The weak areas will be marked per item and element and additional investigation will be made for consideration of a separate detailed examination of the area and the associated procedures. The actions needed for changing the status should discussed with respective departments of the companies and probably others involved as problem owner and problem solver and will be implemented in line with discrepancies found as non conformities in order to be both feasible and desirable on the basis of what is needed to bring about change or improve the conformity to an acceptable level. Proposals for improvement and conformity are identified as "systematically desirable" which means that any proposed change to be implemented in the system improves element's level at acceptable range and as "cultural feasible" which means that the proposed change to be implemented is feasible for the people involved. The most common implementation of proposals defined above is resources and training issues which mainly affecting conformity of system's elements. Feasible or desirable changes are illustrated generically in the table of elements proposed changes which are carried forward in project's activity chapter 5.

4.4 The Audit methodology

According to ISM and ISO standards, an audit is a technique used to gather sufficient facts and information, including statistical information, to verify compliance and conformity with standards. Auditors should select as part of their preplanning a sample size sufficient to give a degree of confidence that the audit reflects the level of compliance with the standard. The auditor, through this systematic analysis, should document areas which require corrective action as well as those areas where the operational, quality, safety and environmental management system is effective and working in an effective manner. This provides a record of the audit procedures and findings, and serves as a baseline of operation data for future audits. An effective audit in my project includes a review of the relevant core elements and sub elements in a way of verification of status by questions and ranking replies of company's relative department personnel. Utilizing the audit procedure and questionnaire developed in the preplanning stage, project can systematically analyze compliance with the provisions of the standards and any other corporate risk policies that are relevant. The audit will be conducted using the ISM, ISO and risk management standards auditing approach:
1. Program - Understand the program (contact participant's persons responsible for each of the departments),
2. Ranking - Assess questions and rank accordingly (compare the sub elements for consistency and standards with existed practices,), and
3. Confidence - Verify confidence on the results by reviewing records, and conducting meeting with all departments' employees.

For each of the requirements of the sub elements, a sufficient justification with documentation should be reviewed to provide physical evidence of the form and quality of the information delivered.
The participant shall then promptly determine and document an appropriate change to each of the compliance findings and document that deficiencies have been corrected.
The auditing standards ISO 19001 offers guidance on how to accomplish the audit. The standard does give insight to project's expectations for the audit survey. No specific mention is made to a ranking system which is introduced by my project, but it is implied that some means of ensuring completeness while determining conformity, compliance and effectiveness which is necessary. The auditing survey is to include a ranking and an evaluation of effectiveness of the process of a safety management system and a deskwork and fieldwork research of the safety, quality, environmental and health conditions and additional elements to verify that the maritime company's risk based management systems are effectively implemented. The format should be designed to provide the auditor with element's ranked sheet which details the requirements of each section of the implemented standard. The questionnaire is properly designed to serve as the verification sheet which provides the auditor with a detailed ranking of the elements and sub elements and the necessary information for actions to be taken to expedite the review and assure that no requirements of the implemented standards are omitted. This verification ranking sheet format could also identify those elements which considered below average and will require further investigation for evaluation or a response action to correct deficiencies. This sheet could also be used for developing the follow-up and documentation requirements.
From risk based compliance perspective, the auditing survey must interpret the standard's elements as it applies to their covered processes, and develop a preventive position of adequate resources and systems for properly managing maritime hazards. The auditing survey is suitable to accomplish the research's aims and objectives and is based on an interpretation of the preamble and the principals of the auditing standard ISO 19001.
As referred above two categories of recommendations are derived from auditing survey compliance: systematically desirable or practicable for recommendations, suggestions, and changes for improvement to the implemented management systems; and cultural feasible where suggestions and changes are feasible for the people involved. Compliance recommendations are given where it is concluded that the minimum ranking level required by the standard is not currently met. Each of the compliance recommendations and changes addresses deficiencies in the companies' management system that must be addressed to improve the effectiveness and to make effort to achieve compliance. It will be also needed to determine which changes and recommendations are fall in the mandatory scheme of the standards like legislative to give prioritization, because it is commonly interpreted that there are some required to be implemented and to be in compliance and those that could be considered optional and could be overlooked. Implementation of those suggestions which are not mandated by the regulation are important also since may be useful for developing a more effective and efficient management system.

4.5 *Implementation*

The research approach which is used in the Survey 1 is associated with the idea of asking questions to a participants groups'. In the beginning the Questionnaire for Maritime Specialists and Advisors issued in order to give specific weight for the participant's representatives and also to create interest by the rest who liked to be involved in maritime risk management. The questionnaire had an introductory letter giving the correspondence needed for guidance. The questionnaire in the beginning was in the form of checklist trying to gather data from a wide range of participants. More than 50 ship related companies selected to participate and contacted mainly by e-mail. The feedback I received was not so encouraging since after a contact I had with some of them whom I fully respect as scientists with particular experience and position in maritime companies (also friends in my long maritime service) explained me that only a few questions could be replied since there was a limited epistemic risk knowledge in the maritime operations. After discussions it was considered better the questionnaire to be extensive and explanatory so to be easily understandable and to be used as a tool for common guidance between the participants. It was also proved that the Survey No 1 entirely based upon the questionnaire submitted was difficult to be worked out since feedback would be limited in terms of fulfillment. For that reason I amended it several times in order to make it in a form of step's questionnaire in a logical and epistemic sequence, and gave all necessary information for the proper assessment of the questions. Finally almost all participants were enthusiastic with knowledge they had received during the survey, which also many of them found educative and undertook duties in their companies pertinent to risk area. The aim of the questionnaire was to devise relative written questions regarding risk management awareness, knowledge and to establish common metrics of risk evaluation and selection of control options and finally to assist in creating a database for activities, hazards, locations, aspects and impacts relative to maritime risk management. A valuable self assessment questionnaire added in the end for further evaluation of how easily applicable could be risk management in shipping companies. Questions issued had carefully defined and described in maritime terminology as possible and assistant explanations given in some scientifically advance areas. Design of the questionnaire was not easy and the amendments made were considered for a long period. The responses of my questionnaire received by e-mail was in the level of 33% for fully completed replies (16 replies) and 16% incomplete (8 replies) but after personal interference I succeeded to achieve additional full replies to the level of 27% full replies (14 replies) which brought an overall level of participation in the Survey No 1 in the level of more than 60% complete replies. Beside the participants replies was not in the level I was expecting it was within the limits I had in mind in order the survey to have the validity and reliability of collected data. 35 to 50% completed and partially completed questionnaires were the area I had considered as low level for reliable results of collected data. The results of the survey presented in the next chapter 5.

The research approach which is used in the Survey 2 is associated with the idea of series of case studies to a participants groups'. After the first survey with which participants took awareness and knowledge how to implement a full scale risk management in maritime activities and understood common metrics of risk

variables a case study survey was considered ideally suited to the aims and environment of the work based research. The participants who had replied in the first survey found very interesting to participate in the case studies as an example and application of the achieved knowledge by the first survey. The replies came relatively very fast since also case studies focused on the participants day to day operations and faced with actual problems and conditions needed proper decisions and solutions. Case studies involved the detailed risk assessment in depth of a number of shipping activities and results regarding level and tolerability of risk. The Case studies for Maritime Specialists and Advisors issued in order to give specific weight for the participant's representatives and also to create interest by those who liked to be involved in depth in maritime risk management. The case studies had only information on the type of ship and activity involved and had not introductory letter since it was placed only to the participant's in the first survey and no additional guidance was needed at that time. The case studies were in the form of checklist for assessing likelihood and severity and tried to gather data from the participants. All 50 ship companies participated in the first survey irrelative their effective reply selected to participate and contacted also mainly by e-mail. The feedback I received was in line with the first survey's replies but the responses of my second survey received by e-mail was in the level of 95% of previously completed replies put in the level of 64% or 32 replies. The chief limitation on the value of the case studies was the question of how far understanding of the specific case and its variables can be transferred to other situations, that is, the findings may not have reliability. Case studies in my research employed highly qualitative data which enables a deep understanding in risk assessment process. Case studies in the survey 2 are considered driven by risk variables and uncertainty elements which subjectively determined in assessment process, but its focus is not on the destructive aspects of negative criticism often associated with them representing in a way the positive or negative experience in specific activities. It's concentrated in the process of managing risks and defines probability and severity of uncertain probable incident and learning from them for the benefits of the stakeholders in the maritime industry. Finally the case studies provided a ranking of shipping activities which are considered having the highest risk index and which should by focused for employment of further attention and additional control measures. Case studies are very important in my research since producing a systematic ranking of the shipping activities in terms of risk and issuing guidance on corporate risk management for these specific activities. Case studies are also very important because dealing with the specific shipping activities of 8 types of ships including specific type's operation and activities. The type of ships the case study dealing with is:

- Bulk Carriers
- Gas Carriers
- Tankers
- Car Carriers
- Chemical Tankers
- General Cargo
- Containers
- Reefer

These extend of the Case study in ship's type considered highly adequate since includes all commercial common used ships in maritime transportation and the results justifying the aims and objectives of the project's research. From the retrieved results conclusions have been produces in relation to the applicability of the risk assessment in maritime management and the way for proper implementation.
The research approached used in the Survey No 3 is associated with the idea of an auditing questionnaire of the core elements recognized by literature review and participants mainly contributing to safety, quality, environmental protection and occupational health. The auditing questionnaire was distributed to the participants and the results collected in a form of ranking each core element in an average score of 8 departments. During the participants' audit, in addition to the recommendations, an overall rating of each core element has been given by using the criteria for core element ranking system.
The auditing questionnaire issued on the basis that goal setting and measurement of conformity towards management elements and goals for the process of safety, quality, environmental protection and occupational health will result in the most effective implementation and management of a process risk management system. The use of the auditing ranking system will allow for more objective measurement of system's status and progress. While the assessment of core element level is somewhat subjective, it is at least a measure of the researcher's opinion on the relative level of completeness and effectiveness of the element.
Criteria for core elements specific weight use a five point ranking system to provide management with a measurement of completeness and effectiveness as compared with the safety, quality, environmental and occupational health management systems of participant's companies.
For the achievement of the comparison and ranking I have determined criteria for evaluation with relative specific weight in order to provide the final assessment for their conformity. In order to evaluate the significance of the criteria among the participants I have distributed in my Survey a specific question for that. The approaches of the various participants will provide with an average of the specific weight for each one of the criterion which will be used further on for the contribution to the critical core elements to the auditing results. During the analysis of the responses for the evaluation of criteria, a qualitative evaluation of the results has taken place to avoid extreme perceptions of intolerant replies. The results of the core elements ranked under the 4 evaluation criteria, each one evaluated in 3 ranking levels such as 3 above average, 2 in average, 1 below average. Further a ranking relative to the weighting factors created a classification of core elements with their specific weight. So the results in each core element in combination with the specific weight produced the final ranking and contribution of conformity in management system. Following that a set of the contribution criteria to safety, quality, environmental protection and occupational health will be set and under which the core elements will be ranked by a system of 5 ranking levels such as 5 much more than average, 4 More than average, 3 average, 2 less than average, 1 much less than average. This ratings is intended respectively to measure the significance of each one of the core elements in the risk based management system and also the contribution and compliance as a relative benchmark to losses from probable unwanted events creating

consequences in property, human, environment and reputation within the maritime industry practices.
The auditing model evaluates the core elements of the implemented management system from two perspectives:
1. The management system design and effectiveness, including:
   - Commitment and diligence
   - Comprehensiveness
   - Appropriateness to the level of hazards of the activities
   - Employee involvement and knowledge
   - Methods employed similar to state of the practice in other industries
   - The completeness and quality of replies
2. The research approaches employed including:
   - Methods and techniques employed for implementation
   - Risk management standards and steps in place
   - Appropriateness to the activities and hazards
   - The completeness and quality of documentation

Finally a relativity analysis developed by using a matrices multivariable processor which by using the results of contributions to management systems and consequences created a result of each core element ranking participation to the each type of consequences.
The steps I have followed in my research briefly presented below:

- Defining aims and objectives
- Defining participants group
- Defining learning sources
- Literature review necessary for
  - Awareness of the existing conditions
  - Knowledge of the current methods
  - Specification
  - Standards requirements
- Survey 1
  - Questionnaire for the evaluation of current knowledge and awareness
  - For establishment of common metrics
  - For participant's self assessment
  - Planning action research and distribution of questionnaires
- Survey 2
  - Case studies for each of the 8 different type of ships
  - Case study list of shipping activities
  - Collection of data of activities risk assessment
  - Analysis of data and ranking shipping activities
  - Planning action research and distribution of case studies
- Survey 3
  - Literature review for ISM and ISO core elements
  - Questionnaire for common core elements
  - Auditing questionnaire for conformity of core elements in the company
  - Collecting data from eight departments
  - Anagoges of the results to the weighting criteria

- Ranking of core elements
- Analysis and evaluation of results
- Contribution of core elements
- Relativity analysis to consequences
- Final ranking based on consequences

- Producing the report
  - Conclusions
  - Further study
  - Relativity ranking software

My research has divided in the directions of implemented ISM, ISO standards and risk management. The following table presenting the existed, modified and new issues added in to the management system by my project's research.

MANAGEMENT SYSTEMS				
RISK MANAGEMENT		Existing	Modified	New
	Existing	ISM ISO 9001 ISO 14001 OHSAS 18001	CRITICAL CORE ELEMENTS OF ISM AND ISO	IASMAR SYSTEM INNOVATION
	Modified	RBDMP RISK ASSESSMENT OF ACTIVITIES	ASSESSMENT OF RELATIVITY	PROACTIVE AND PREDICTION INNOVATION
	New	RISK MANAGEMENT DEVELOPMENT	RANKING ON CORE ELEMENTS	CONTINUOUS IMPROVEMENT INNOVATION

Table 4.5 Existed, modified and new issues

The proposed research was feasible but as far as regard time schedule it took me more time than initially considered because of two reasons:

1. Development of standards. Initially I had considered 4 standards involved in my research for which also had the specialty, knowledge and certification as Auditor/ Lead Auditor. The OHSAS 18001 also added in my research and relative skills acquired as auditor of OHSAS 18001. Additionally the standard ISO 14001:1996 has been displaced by ISO 14001: 2004 for which also additional skills acquired to meet latest requirements and philosophy. During the period of my research I have acquired knowledge and certification of the following relative areas

i. ISM Auditor
ii. ISO 9001:2000 Auditor/ Lead Auditor
iii. ISO 14001: 2004 Auditor /Lead Auditor
iv. OHSAS 18001 Auditor
v. Risk Management and Incident investigation
vi. Classification and statutory surveys
vii. Tanker Management and self assessment

2. Development of risk management interest and directions by IMO which was important in order to keep research in the right track and to be suitable with future requirements.

The access to information which received mainly by the internet was adequately and informative in all extend. Additionally books of IMO and BSI were helpful for common and reliable interpretation of data.

The project's research process had success and was a learning tool first for my company's staff from where I had active involvement and feedback and also by other participants during discussions for investigating and generating ideas which confirmed the effectiveness and validity of my project. The project itself but also the research process was informative and educative to the internal colleagues as well as to the participants since was specific problem needed to examined and adopt in the near future. The project also raise participant's interest since it was something they had heart but not systematically involved and involves a major organisational change intervention. Even though my risk management project initiated in 2002 and relative research made since then the seminars for risk management in shipping stared in the end of 2004 concluding the innovative character of my project and bringing the forthcoming significance of risk management in shipping. The proposed research approach, the research tools have been used for the establishment of surveys and the collection, analysis, and evaluation of data and information received as well as the steps for materialization of the weighting, contribution and relativity analysis considered appropriate for the following reasons:

- The sequence of steps and the research tools for materialization, comparison and relativity analysis are in line with the existing proposed guidance, regulations and standards and criteria which selected are in order with the prevailing perception in maritime industry and science
- In the work field my project is a research and development in an aspect of management that enhances organizational management and working practices and the chosen and methods used underpin my point of view and critically evaluated over my project.
- The research families have chosen and the research approaches which followed obtained the scientifically proper approach for the materialization of the relativity comparison of the management systems and risk management following selected criteria.
- Data and information collected by literature review and my 3 surveys used, analyzed and evaluated and fulfilled adequately in my opinion the aims and objectives which have been placed initially in relation with ranking and ease of implementation.

Summarized the research methodology and by using the optimal combination of the approaches, tools and methods I am confident that the results and

conclusions of my research are valid for the proper risk ranking and contribution to the prevention of accidents in maritime industry.

4.6 Ethical issues and constraints

During my project's research there were raised a number of ethical issues related to my research progress. The assessment and risk analysis by auditing has largely to do with the existing level of safety and the differences in opinion to manage these risks and provide mitigation measures for tolerability conversion. The companies participating and were involved in auditing survey had risen since the very beginning the issue of confidentiality which was very critical since assessment results could be used as prove for the level of conformance with mandatory and other requirements. Additionally participants raised the issue of the results of self assessment and relative ranking to safety, quality, environmental and occupational heath implemented management system to a potential casualty level of consequences which is a kind of admission for the standard of Management Company and its fleet. This could be used as an admission of relative responsibility in a potential accident with adverse for the company side effects. Under these circumstances I have tried to avoid faulty assessments and ranking presenting all companies in an excellent level so as to avoid any implications from my research by declaration of confidentiality I had made in order participants to feel confident that results will be presented anonymous and only internally to each one itself and relative data will not be named and not published without their written consent. Insurance companies which have been involved in data resources were limited to those not related to the shipping companies involved in surveys. Actually I have considered a mistake my decision to accept participation of Insurance companies in any type beside the great interest and encouragement they provide for my research and further decided not to be given this information at the moment. So I was very careful in handling with proper confidentiality any potential issue which may arise in discussions with external contacts. The key purpose of my project is to try and succeed to put all the parties involved in line to accept the risk ranking and the auditing assessment in combination with methods of safety assessment used so as to produce a practicable and workable risk management tool. Many of the results presented in this research will come as no surprise to the people who worked on ship management companies, Masters or skilful crew. As a result of the research the participants after all have created a very good idea of what is important in determining risk factors in shipping activities. A very important question was how this research and the ranking help management to create a significant management change which had replied in the results. By the results the management should feel assured that the estimation of risks are likely to cause a significant accident are properly and successfully identified, addressed and managed. The IASMAR tool proved reliable and good predictor by ranking activities and weak management areas. The data of activities and auditing models is a dynamic list which assists practically all staff to face and handle daily cases and problems. There is also now a benchmark and concrete examples of how by data acquired to help management make decisions that are defensible to cases.

Insurance companies which have been involved in data resources had not related to the data collected from shipping companies involved in auditing plan. I was very careful in handling any potential confidentiality issue which had risen in discussions with external contacts. The key purpose of my project was to succeed to put all the parties involved in line to accept the activity's risk ranking and the auditing assessment in combination with core elements so as to produce a practicable and workable risk management tool which I finally achieved successfully. The problem I faced during my research progress was significant in the beginning as the initial attitude of participants was not friendly and a lot of criticism delivered regarding the approach and usefulness of maritime risk management by leading discussions to high theoretical level with no sense. Additionally a lot of discussions took place for the existing risk analysis/ assessment software presented for the use of security management and other industries risk management. It took me a long time and discussions with opinion leaders among the participants to explain my approach which with no doubt developed constantly by reading and taking courses in relative fields. The issue also discussed creating tension to the audience was the use of metrics in things which are subjective and the liabilities which were significant compared to the professional level of undertaking. The qualification of professionals and the level expertise was also an important issue since the background of the staff able to carry out assessments did not define. I made attempts to explain as much as possible the meaning of numbers and metrics in modelling tools and a draft description of duties and responsibilities of staff handling risk issues defined during discussions and presented in this chapter. There was also much sensitivity in risk related issues to that purpose which I have tried and succeeded to short out by using my professional background and relation with colleagues in participant companies. The recognition of the usefulness as the project created results by the participants was certainly of concern in assessing implementation by ship managers. The project concluded with three months delay since I had to face forthcoming changes in ISO 14001, FSA and the huge amount of data collected for further analysis. Another important issue was the selection of the participants which was made by my self and my colleagues as a sample representing elements of data necessary to complete my research aim. Of course the limitation of random samples could not be fulfilled as my research study had boundaries of SQEOH standards and specific type of ship activities. I had also difficulties in order to keep my report in a manageable size as I have explained in the relative reference but I set absolutely necessary limitations in data and replies and finally I succeeded to present it within the approved size. The data and relative information will be used as a guide in a wide range of shipping companies for producing their own integrated system which hopefully will succeed if not to put an end but significantly improve to reduce or even to eliminate casualties. There was also much sensitivity when collecting the vast amount of data and received information which I could not succeed to short out properly without the assistance of my colleagues, my company's staff, my professional background and my relation with participants affiliated companies. I would like to thank them all since I could not succeed without their assistance and support throughout my project's research.

CHAPTER FIVE: PROJECT ACTIVITY

5.1 Setting limits and time schedule

My wish for the research in Doctoral level was known to my professional environment and my family and my commitment to succeed was for me the basic motive to weather through the difficulties and problems during my research. Since very beginning of my initiative to undertake this research project I have discussed with my family to get common understanding and consent for the time and occupation I had to devote additional to my regular work, and from my professional colleagues their support and assistance in fulfillment of my professional duties and cooperation in my research. Dr. Passaris guided me in the right track to achieve the final conceptual framework of my research. My scientific background and my professional experience enhanced by the seminars I received for in risk and management systems presented in the previous chapter. My experience in technical and administrative positions in my company gave me the opportunity to deal / handle and solve a wide variety of cases and aspects relative to my research and project which have provided background for the completion of the proposed research approach and its results. On completion of my project it was proved that I am able to manage, plan and materialize a potential research major project, to carry out a focused critical literature review, and to follow a systematic approach for design a program of a research, to effect data collection and analysis integrating research aims, to follow data requirements and methods of collection and analysis, taking into consideration ethical and other constraints and to meet requirements. My capacity in management and in literature review and my up to date knowledge and experience assisted me in preparing and editing of my research project and surveys which in my opinion presenting a reliable and accurate view of the scope defined and the ability required to carry out the project. In the present chapter described the activities materialized for the achievement of the aims and objectives of my project.

Specifically:

1. Determination of aims and objectives

The clear and specific aims of my project for the integrated risk auditing system and the ease of implementation as the aim of my project resulted the cornerstone of my research in combination with emanated objectives of my project.

2. Determination of participants group

The group which is addressed the present research and to whom the usefulness has determined is firstly the University of Middlesex and my company and then any other shipping related company dealing with this project such as Ship managers, Insurance Companies. Flag, Class, ECT.

3. Literature review

Literature review used and considered relative to the field of my research retrieved from many sources and used for the

- Review of the existing condition and methods of my research
- For the description of methods of risk management
- For the standards related to ISM, ISO, Risk
- For the determination of core elements
- For multivariable analysis

Literature review is a big part in my research and covers major parts of Chapters 2 and 3.

4. Surveys

During my research I have conducted three surveys for experts and maritime specialists of about 50 shipping related companies. My initial consideration was to issue an auditing survey as is Survey 3 but during implementation a more informative survey considered necessary and the Survey No 1 issued in form of a questionnaire for efficient research results. Concluding the 3 surveys, a multivariable model was constructed and administered to the most experienced persons selected from the participation of my company during the research to carry out calculations.

Table 5.1 details all the surveys carried out which also questions and raw data attached to the Appendix form.

Period	Type	Method	Participants	Area
May 2004	*Survey 1* Rev.1	Questionnaire	50 Companies	Risk perception
September 2004	*Survey 1* Rev.2	Questionnaire	50 Companies	Risk perception
August 2004	*Survey 2.1*	Case study	9 Companies	Bulk/Risk
August 2004	*Survey 2.2*	Case study	3 Companies	Chem./Risk
August 2004	*Survey 2.3*	Case study	4 Companies	Gas/Risk
August 2004	*Survey 2.4*	Case study	6 Companies	Reefer/Risk
August 2004	*Survey 2.5*	Case study	3 Companies	Car/Risk
August 2004	*Survey 2.6*	Case study	5 Companies	Cont/Risk
August 2004	*Survey 2.7*	Case study	4 Companies	General/Risk
August 2004	*Survey 2.8*	Case study	6 Companies	Tanker/Risk
November 2004	*Survey 3.06*	Audit study	15 Companies	Risk Auditing
January 2005	*Survey 3.10*	Audit study	4 Companies	Risk Auditing
March 2005	*Survey 3.11*	Multi-variable	My company	Supplementary
May 2005	*Survey 3.12*	Multi-variable	My company	Supplementary

Table 5.1 Surveys List

Volume of my research's report

The collected information had vast amount of data which resulted the incensement of my project's volume which maybe is not desirable as per established rules. This made me to review it many times in order to reduce it as much as possible, but even after proper reduction remained huge. I would like to apologize for that and justify my decision presenting the reasons:

- My research dealt with 4 management standards ISM, ISO 9001, ISO 14001, OHSAS 18001 and Risk Management, which means that the volume reviewed to justify common core and additional elements of these standards in relation with risk management and to justify relationship needed many references and interrelations thing which created a volume of paperwork.
- My research dealt with hundreds of activities, location of activities, hazards, aspects, impacts, consequences and other valuable variables contributing to risk management process
- My research dealt with a serious number of methods, techniques and indices creating the common metrics for risk management process.

- My research dealt with risk management in Maritime management corporate and specific issues which are theoretically a contexture of risk management in other industries to maritime industry.
- My research dealt with criteria which firstly implemented as weighting factors to common core elements of standards with risk management
- My research dealt with theoretical correlation of safety, quality, and environmental and occupational health contribution to extend of consequences severity of an unwanted incident.

All the above drove me to the conclusion that is better to present necessary information for my project even if volume considered substantial.

5.2 Survey 1 analysis (Questionnaire)

Period	Type	Method	Participants	Area
May 2004	*Survey 1* Rev.1	Questionnaire	50 Companies	Risk perception
September 2004	*Survey 1* Rev.2	Questionnaire	50 Companies	Risk perception

The first survey (Survey 1) was a survey in the form of questionnaire for Maritime specialists and advisors to include different type of participants. The Survey 1 first issued and distributed in the final form in May 2004 and during the implementation amended with Rev.2 to include additional ideas in Sept.2004.

The questionnaire was intended to evaluate the risk perception of the maritime specialists and advisors and assess the overall awareness in shipping activities, risk methods and reporting.

The specialists will normally have a marine related manager, officer or engineering background. The scope of the questionnaire in Survey 1 covers the area of shipboard activities and risk management sectors which are important for risk process awareness. Description of risk management process and methods used in maritime operations described not only for appraisal of risk conditions as far as regard severity and likelihood, but also of supporting management systems, including policies, procedures, manuals and documentation. Finally a self assessment questionnaire attached for evaluation of awareness in risk based decision making process. Questions are generally phrased to be answered with a simple multiple choice or a yes/no reply, supported by comments in some areas where needed a qualitative appraisal. The contents of the questionnaire are structured to provide an easy reference to the principle areas of marine risk management in overall operation that have been evaluated. The goal of the Survey 1 was also to build a group of specialists to work in the Survey 2 in order to create a reliable model for evaluation of Management Systems indices in terms of risk, likelihood and consequences.

The configuration of the questionnaire which derived in 8 sections regards to three main obstacles for wider use of risk management methodology which are:

- Low awareness of risk elements,
- Limitations of existing risk management approaches, and
- Lack of empirical evidence of the usefulness of risk management methods.

This questionnaire addresses all three of these issues.

First, is presented a general questionnaire pertinent to the participants' statistical data The Section 1 sets the profile of the participants' elements, their capacity and main categories creating a data base with considerable importance relative to my project. Ship managers, insurers, consultants and authorities were my initial target group. Companies implementing ISM and ISO standards are mostly preferable as target group by the participants. Eight (8) types of ships selected for the survey's analysis Bulk Carriers, Chemical Tankers, Gas Carriers, Car Carriers, Oil Tankers, Reefers and Containers present a risk management profile that attempts to avoid the limitations I had recognized in many current risk management approaches.

The Section 2 sets the profile of the type and size of ships owned and managed by participants. The age also assessed for participant's fleet in this section considered critical and representative for risk contribution with importance relative to my project.

The Section 3 sets the principles of Hazard Identification developments in a broader perspective by referencing to selected techniques in the area of maritime management and awareness of causation categories and chain. Section 3 also furthers the developments by introducing a list of shipping and shipboard activities for all 8 types of ships in which hazards applied in a process model of the qualification of risk management.

The Section 4 sets the achievements in level of awareness and introduction of the concept of precautionary risk analysis referencing to selected methods and parameters in the area of maritime management. The roles of impact categories and location parameter, model and implementation awareness are questioned from the point of view of importance verification of risk analysis. The concept of qualification and quantification of risk analysis is also introduced. It entails a verification of conceptual framework for communicating quality-related properties of risk assessment. Also a list of maritime incidents and aspects has created on the use of selection of top events in order to determine an initial judgment of importance.

The Section 5 sets the achievements in level of awareness and introduction of the concept of risk assessment methods referencing to selection of indices for frequency and severity parameters. Formal Safety Assessment guidance was applied to establish severity indices for human fatalities and relatively additionally relative elements added to assess and evaluate the safety and environmental incidents for severity. The research brought in light the various metrics of indices and the use of International Maritime Organisation guidance for risk index in combination with actions and timescale proposed to the participants for risk assessment implementation. The methodological framework of Bow Tie diagrams was questioned as far as suitability for risk control options determination and interrelation between participants. Also a list of risk control options and stakeholders has created on the use of risk assessment in order to evaluate participants' initial judgment of consequence importance.

The Section 6 sets the achievements in level of awareness and introduction of the concept of risk management methods referencing to selected criteria as to acceptability of risk and efficiency vs. cost relation of risk reduction measures. Valuation of risk to human life was introduced to participants based on ALARP principal and a correlation developed to support the decision-maker in defining incentives to reach consensus decisions in this specified decision context. ICAF

level identified to participants since determined as incorporated in compensation covered by the protection and indemnity insurance for specific conditions and cases. Risk control options presented in this section for efficiency and cost evaluation which applied to establish efficiency indicators for prioritisation of implementation based in cost benefit analysis.
The Section 7 sets the achievements in level of auditing, self assessment and review preparing a proper and efficient risk management implementation which allows a thorough presentation of risk scenarios, uses a sound approach for ranking risks, and supports multiple goals and stakeholders. Risk gap analysis and assignment of risk duties introduced that makes possible the use of collected information in the form of non conformities, accident incident reports and near misses to values which can further examined and used for prediction models. It was also discussed the inherent difficulties in assigning risk management duties empirically and stakeholders significance questions carried out to evaluate the feasibility of the project.
The Section 8 deals with confidence of easy implementation of a risk management system, the resources and adoption time needed for implementation. There was a basic approach used to contact the survey primarily with questionnaire submitted for fulfilment and personal or telephone contacts for parts which were considered of complicated nature and of complex concept during implementation. Despite that the questionnaire was self directed and self administrated consisted of questions to be answered by participants a lot of effort paid for the complete understanding and data collection to obtain information reflecting personal as well as organisational point of view. Minor modifications related to newly introduced OHSAS were suggested which have been incorporated in the final version that was sent out to gather information from the 50 participants. There were a lot of participants who treated my survey positively and assisted me with great pleasure by fulfilling properly the questionnaire with communality because they considered the usefulness in day to day operations. The main objection I have faced was the argument that risk management in corporate or specific issue level has not yet adopted under a common approach and FSA which is tested in rule making process is doubtful to implemented in a corporate level due to inheriting constraints for the reason that is not a management system but only an assessment method. Also despite recent publications and seminars in risk assessment, knowledge about possible risk management implementation methods and tools has not reached by most maritime managers, and lack of knowledge about risk management techniques and practices was cited as the most common reason for not interesting participating in risk management survey. There was an intensive effort to convince them and finally I succeed that the importance of my project based exactly in the perception that includes a risk management system and specific issue risk management so as all option involved and secondly this is a system which saving lives, funds, efforts and reputation by achieving continuous improvement which is the aim of any implemented management system.
The conclusion is that in Maritime industry whatever is not compulsory worth little attention irrelative if it is forthcoming, mainly because of the need of scientific background as well as by the burden of daily operational and technical irregularities which give marginal chances for voluntarily efforts.

5.3 Survey 2 analysis (Case studies)

In the Second Survey 2 the following researches as case studies took place:

Period	Type	Method	Participants	Area
August 2004	*Survey 2.1*	Case study	6 Companies	Bulk/Risk
August 2004	*Survey 2.2*	Case study	3 Companies	Chem./Risk
August 2004	*Survey 2.3*	Case study	4 Companies	Gas/Risk
August 2004	*Survey 2.4*	Case study	4 Companies	Reefer/Risk
August 2004	*Survey 2.5*	Case study	3 Companies	Car/Risk
August 2004	*Survey 2.6*	Case study	4 Companies	Cont/Risk
August 2004	*Survey 2.7*	Case study	4 Companies	General/Risk
August 2004	*Survey 2.8*	Case study	5 Companies	Tanker/Risk

The second survey (Survey 2) was a sur3ey in the form of case studies for Maritime specialists and advisors and was applied to eight types of ships which are:

- Bulk Carriers
- Gas Carriers
- Tankers
- Car Carriers
- Chemical Tankers
- General Cargo
- Containers
- Reefer

The Survey 2 first issued and distributed in August September 2004 and was based on the elements of Survey 1 mainly regarding shipping and shipboard activities and elements of relative ranking of risk indexing. The case studies were constructed to use data collected regarding probability and causes of an unwanted event in combination with risk index resulted from the likelihood and severity level of each shipping activity for all 8 types of ships. For that reason case study derived in two supplementary parts. The first introduced for the determination of risk quantification for likelihood and severity level. In the Appendices is given the tables used for the survey and on how this section has filled out.

The purpose of the first part is to obtain participants opinion regarding of how various activities in relation with hazards affect the probability of a failure in safety, quality, environment and occupational health issues which is related mostly to one of the four direct or indirect causes. In addition for each estimate is important and defined how confident the participants were in their replies. It was taken into consideration that participants found difficult to give an answer to some questions but best guess required based on the experienced on their duties. These tables were also used in multivariable process as an opinion regarding the relation and importance of each factor as a prediction in safety, quality, environmental and OH&S incident.

Type of ship: Bulk Carrier					
Area of Activity: Safety					
Operation of Activity: Ballasting					
Ship's condition: Discharging					
Question: Ballasting during discharging may affect its probability of having a safety accident in a future ballast operation. For each type of failure indicate how likely it would be for this activity to have such incident					
Place X in box	Probability of having an incident				
Cause type	Much less than average	Less than average	Average	More than average	Much more than average
Unsafe act	(1)	(2)	(3)	(4)	(5)
Unsafe Conditions	(1)	(2)	(3)	(4)	(5)
Human Factors	(1)	(2)	(3)	(4)	(5)
Technical Factors	(1)	(2)	(3)	(4)	(5)
Confidence to your estimates of exposure					
Place X in box	Not confident	Low confidence	Average confidence	High confidence	Very high confidence
Exposure	(1)	(2)	(3)	(4)	(5)

Table 5.2 Incident's Probability template

The scale of the probability having an incident considered from one (1) to five (5) with 1 corresponding much less than average probability and 5 corresponding much more than average probability. Similarly the scale of confidence to estimates for exposure considered from one (1) to five (5) with 1 corresponding not confident and 5 corresponding very high confidence. The participants asked to provide a confidence level in their probability estimates on a 5 point scale presented above. The result of the success risk index SRI which provides the qualitative risk characteristics of the activity determined by the multiplication of the possibility of an incident by a cause P^n and the confidence for the exposure C^n. There were two possible uses of this information, one use would be to assign uncertainty distributions to the estimates and the other use could be the relation of the participant's elements (implemented management system, types and age of fleet, current conditions ect.) and level of confidence regarding exposure estimates. A regression was run comparing the safety, quality, environmental, and occupational health SRI ranking versus Risk Index for providing a relationship between the possibility of a prevailing cause and actual exposure to formally calculated risk index. Table in the appendices shows the average score regarding safety, quality, environmental and occupational health issues of each activity and the confidence level. The results of this part of the case study are very important because it ranks activities for the probability of unwanted event and its relation to management system. The areas prioritised and relative management system focused on the activities of high priority. Evaluation made with existing control options in place. The luck of information on management systems and probability of having an incident which is the primarily concept of

risk index, could be a significant source of error in the case studies. Of course the quantification of probability and its confidence is a subjective opinion since is a qualitative approach but the determination of objective shipboard activities limited the boundaries of an extreme opinion.

Top Event	ACTIVITY VESSEL BULK CARRIERS	Unsafe Act	Unsafe Condition	Human Factor	Technical Factor	EXPOSURE
Freight & Hires	A1. Invoices Non Payment	1	4	1	1	2
	A2. Invoices delay of payment	1	4	1	1	4
	A3. Insolvency of Charterer	1	4	1	1	1
	A4. Arbitrarily deductions	1	4	1	1	2
	A5. Renegotiation of hire	1	4	1	1	1
	A6. Authorize agent to sign B/L	1	4	1	1	4
	A7. B/L terms for payment	1	4	1	1	2
	A8. Technicality clause	1	4	1	1	1

Table 5.3 Activities collection of estimates template

Beside that the final results screened in an average and extreme replies adopted with care so as to reflect an average to opinions and estimates. Level of confidence is another subjective opinion but functioning in combination with risk estimates so as to provide a more reliable data.

The Part 2 of the case studies is an application where responders evaluated the likelihood and severity of the same activities as before as a precautionary risk assessment and the level of their confidence. The research approach in case studies is constructive research with emphasis on conceptual and decision of the probability of occurrence and qualitative risk model development.

Top Event	Activity Operations BULK CARRIERS	SAFETY	QUALITY	ENVIRONMENTAL	OH&S	LIKELIHOOD Min LIKELIHOOD Max 01	03	04	05	07	CONSEQUENCES Min CONSEQUENCE Max 01	02	03	04	CONFIDENCE
Freight & Hires	A1. Invoices Non Payment					☐	☐	☐	☐	☐	☐	☐	☐	☐	
	A2. Invoices delay of payment					☐	☐	☐	☐	☐	☐	☐	☐	☐	
	A3. Insolvency of Charterer					☐	☐	☐	☐	☐	☐	☐	☐	☐	
	A4. Arbitrarily deductions					☐	☐	☐	☐	☐	☐	☐	☐	☐	
	A5. Renegotiation of hire					☐	☐	☐	☐	☐	☐	☐	☐	☐	
	A6. Authorize agent to sign B/L					☐	☐	☐	☐	☐	☐	☐	☐	☐	
	A7. B/L terms for payment					☐	☐	☐	☐	☐	☐	☐	☐	☐	
	A8. Technicality clause					☐	☐	☐	☐	☐	☐	☐	☐	☐	

Table 5.4 Activities collection of risk estimates template

In part 2 the participants were asked to provide estimation on risk index provided by the estimation of

- Likelihood or frequency of the hazardous event occurring. The scale of the likelihood having an incident considered from one (1) to five (7) with 1 corresponding much less likelihood and 7 corresponding much more likelihood. The scale represented by 5 check boxes representing levels 1,3,4,5,7 corresponds to logarithmic FI frequency index 1,3,4,5,7
- Severity of consequences. The scale of the severity having an incident considered from one (1) to four (4) with 1 corresponding much less severity of consequences and 4 corresponding severe consequences. The scale represented by 4 check boxes representing levels 1234 corresponds to logarithmic SI frequency index 1, 2, 3, 4.The 05 boxes should be empty as for the scales finally adopted IMO guidance instead of other scales issue raised extensively in Survey 1.
- Confidence for the exposure level in their estimates on a 5- point scale.

Based on the above calculations emanated by RI=FI+SI and resulted $SRI=P^n*C^n$ a table is produced determining the risk index and success risk index of the specific activity. The level determined in combination with action required:

Risk matrix ☒	Trivial	Tolerable ALARP	Moderate	Substantial	Intolerable
-IMORI=SUM FI+SI☐	0-2	3,4,5	6-7	8-9	10-11
- SRI=MUL SI*FI ☐	1-2	3-4	5-9	10-15	16-25

Risk Level	Actions and Timescale
Trivial	No action is required. No documentary records to be kept
Tolerable ALARP	No additional controls required. Development of existing control and procedures without extra cost. Monitoring required for ensuring that controls are maintained.
Moderate	Efforts should be made to reduce risk, but cost of additional controls should be measured and limited Additional risk control options should be implemented within a defined time period.
Substantial	No work should be commenced until the risk has been reduced to acceptable level. Where risk involves work in progress urgent action should be taken. Additional control options should be implemented but limited to "reasonably practicable". In case the cost of such measures are grossly disproportionate to the improvement gained the risk considered tolerable
Intolerable	Work should be commenced only if risk reduced to acceptable level. If cost to reduce risk to acceptable level is grossly disproportional it can be considered not reasonably practicable. Risk can be undertaken in exceptional circumstances.

Table 5.5 Risk Index levels

The conclusions are presented as responses to the two parts. As stated earlier, although it is the difficulty of a case study to base in estimates on an individual group the advantage is that these estimates and conclusions emerged based on judgement from shipping related staff and the analysis based on qualitative methods and experienced criteria. The risk management framework as implied in the case study suggests a structured analysis of risks is generally appropriate.
In general it was proved that the risk management approaches as implemented in two steps case studies by the shipping companies participated were consistent with the philosophy and process of the risk management framework as discussed in Survey 1. The deliverables from the case study could be summarised as follows:

Participants carried out a walkthrough for the marine activities listed and reviewed probability of occurrence in relation with safety, quality, environmental and \OH&S type of incidents in relation to causation analysis and exposure confidence. This was a complex evaluation for each activity item but definitely proved the relation of risk index and causation for probability of exposure. This data is important since RI is a single value and an event could happened and can have many different causes and outcomes , so risk is better described as a combination of frequency (a parts from how often and possible) and consequences will in order to develop risk management system reliability and predictive analysis. The case studies for all 8 types of ships established ranking and priorities for risk assessment. Based on the outcomes participants have managed risk of activities in formal or informal basis and properly allocate required actions. Specific knowledge and experience played a vital role in the identification and determination of various scenarios related to the shipping activities. The correlation between RI and cause estimates in the prediction of cause probability investigated to cover the basic steps within safety assessment. The estimates from the participants were subjective but considered necessary and practicable to be used when there is limited available data. In this case study, the effect of practicality was evaluated. Evaluation of implemented risk management solutions is an important task for determining if the solutions serve the needs and if any potential problems should be sorted out. In this case, the evaluation was also needed to justify the programme and the project.

5.4 Survey 3 analysis (Auditing)

In the survey No 3 the following researches took place in the form of auditing surveys and process.

Period	Type	Method	Participants	Area
November 2004	*Survey 3.06*	Audit study	15 Companies	Risk Auditing
January 2005	*Survey 3.10*	Audit study	4 Companies	Risk Auditing
March 2005	*Survey 3.11*	Multi-variable	My company	Supplementary
May 2005	*Survey 3.12*	Multi-variable	My company	Supplementary

The third survey (Survey 3) was also a survey in two parts and in the form of identification and auditing of elements for evaluation of Safety, Quality, Environmental and OHSAS management system's identical and common risk elements which are important on assessing the risk performance of each management system requirement. From the first part of the survey 3.06 the particular risk based core elements identified for each of the Operational Safety, Personal Safety, Quality, Environmental and Occupational Health management system. The objective of this auditing survey is firstly to verify that core elements have adequately defined in order to assess shipping company's conformance to risk and other standards requirements and also to create an electronic auditing database of the elements and sub elements that will assess all audit findings. The risk core elements which link the risk management with ISM and ISO standards selected carefully by using literature review and experience taking into consideration significance to the maritime management and auditing capabilities.

During the initial the following 15 core elements determined for the evaluation of the condition of the implemented risk based management system and relative questionnaires created to rank and verify conformance. A separate column has created in order to assess confidence on the estimates in a 5 scale ranking approach. The core elements identified are the following:

A.	NATURE AND SCOPE OF DECISION
B.	MANAGEMENT RESPONSIBILITY
C.	STAKEHOLDERS ANALYSIS
D.	RISK SCENARIOS
E.	PERSONNEL RECRUITMENT
F.	OPERATION AND NAVIGATION
G.	HAZARD IDENTIFICATION
H.	CARGO, BALLAST, MOORING OPERATIONS
I.	RISK ANALYSIS
J.	PLANNED MAINTENANCE
K.	RISK ASSESSMENT AND ESTIMATION
L.	RISK MANAGEMENT AND EVALUATION
M.	ACCIDENT & INCIDENT INVESTIGATION
N.	RISK PREPAREDNESS AND PLANNING
O.	RISK SELF ASSESSMENT & AUDITING

The core elements identified above have a specific weight contributing to the assessment of ranking of the auditing collected data. In order to identify and evaluate relevant core elements contributing to safety, quality, environmental protection and occupational health management systems I had created a core element category comparison in order to get the specific weight of each element. In order to do that I have created a list with 15 core elements this is used for evaluation. In this list which presented below I have asked from participants to give me relative importance between core elements in the risk based management system for predicting accident in each of the area of safety, quality, environmental protection and occupational health. In the first stage participants should cross off any core elements which consider not important if any. Then I have asked to rank the remaining elements in order of importance on predicting accidents starting most with to least important. The ranking is from 1 most important up to maximum 15 least important. Then I have asked the relativity between the elements by ranking 100 the most important and identify how much less important is the next one. The difference is the specific weight of the element. By continuing down the list a ranking of indicating relative importance and specific weight created which in any case progressively should be lower than previous one. In the resulted table the total weight is the sum of all weights given to the core element by all participants. Then the elements processed by the amount of weight received and expressed in ratio for contribution to the final score.

Further to the implementation of the initial auditing survey and the received results it was considered necessary to include in the auditing plan additional 5 elements which made more specific results in the area of efficiency of the implemented management systems. With the additional elements identified in the beginning of my research a list of 20 core elements created and presented below:

Same as previously made and explained a table of elements relativity was created for each one of

- Safety as per ISM
- Quality as per QMS ISO 9001: 2000

- Environmental Management System ISO 14001:2004
- OHSAS 18001
- Risk Management

as the tables below:

RISK MANAGEMENT CRITICAL CORE ELEMENTS	
1.	NATURE AND SCOPE OF DECISION
2.	LEADERSHIP AND MANAGEMENT
3.	STAKEHOLDERS AND COMMUNICATION
4.	RISK SCENARIOS
5.	PERSONNEL RECRUITMENT AND TRAINING
6.	OPERATION AND NAVIGATION
7.	HAZARD IDENTIFICATION
8.	CARGO, BALLAST AND MOORING
9.	MANAGEMENT OF CHANGE
10.	PERFORMANCE STANDARDS
11.	RISK AND CRITICAL TASK ANALYSIS
12.	PLANNED MAINTENANCE
13.	RISK ASSESSMENT AND ESTIMATION
14.	RISK MANAGEMENT AND EVALUATION
15.	ACCIDENT INVESTIGATION AND ANALYSIS
16.	PURCHASING AND SUBCONTRACTING CONTROL
17.	RISK PREPAREDNESS AND PLANNING
18.	MATERIALS AND SERVICE MANAGEMENT
19.	RISK SELF ASSESSMENT & AUDITING
20.	MEASUREMENT ANALYSIS AND IMPROVEMENT

Table 5.6 Critical Core Elements

Safety as per ISM/ Quality or as per QMS ISO 9001:2000			
	Description of element	**Ranking**	**Weight**
01	NATURE AND SCOPE OF DECISION		
02	LEADERSHIP AND MANAGEMENT	1	100
03	STAKEHOLDERS AND COMMUNICATION		
04	RISK SCENARIOS		
05	PERSONNEL RECRUITMENT AND TRAINING		
06	OPERATION AND NAVIGATION		
07	HAZARD IDENTIFICATION		
08	CARGO, BALLAST AND MOORING		
09	MANAGEMENT OF CHANGE		
10	PERFORMANCE STANDARDS		
11	RISK AND CRITICAL TASK ANALYSIS		
12	PLANNED MAINTENANCE		
13	RISK ASSESSMENT AND ESTIMATION		
14	RISK MANAGEMENT AND EVALUATION		
15	ACCIDENT INVESTIGATION AND ANALYSIS		
16	PURCHASING AND SUBCONTRACTING CONTROL		
17	RISK PREPAREDNESS AND PLANNING		
18	MATERIALS AND SERVICE MANAGEMENT		
19	RISK SELF ASSESSMENT & AUDITING		
20	MEASUREMENT ANALYSIS AND IMPROVEMENT		

Table 5.7 Critical Core Elements ranking and weighting

The total weights collected represents 100% of the value and scaled weights produced for each element by dividing each by the total weight. In order to create a detailed and reasonable evaluation of weights in each element the following table was created and fulfilled automatically by data collected above.

01	NATURE AND SCOPE OF DECISION		
CONTRIBUTOR	DESCRIPTION	RANKING	WEIGHT
Safety Contribution	Assigned as the significance of the element to the operational safety		
Quality Contribution	Assigned as the significance of the element to the quality of provided services		
Environmental Contribution	Assigned as the significance of the element to the environmental protection		
Occupational Health Contribution	Assigned as the significance of the element to the Occupational Health/Personal safety		
Risk Management Contribution	Assigned as the significance of the element to the Risk Management		

The table of the total weights presented below:

Element	Safety	Quality	Health	Environmental	Risk
01					
02	2932	2739	2532	2846	2532
03					
Total weight	30270				

And Total scaled weights presented below:

Element	Safety	Quality	Environmental	Health	Risk
01					
02	10,2%	9,32%	9,7%	8,8%	11%
03					
04					
Scaled weight	1				

Table 5.8 Elements ranking per SQEOH relationship

The core elements analysed in subcategories and questions and presented analytically below as defined by the feed back received during the initial survey and reproduced by adding the 5 core elements. It is also presented the diagram of elements interrelation in the integrated management system as provided in the guidelines of the latest standards.
In the first part the common elements were analysed, evaluated and ranked by the following criteria:

1. Practicality and feasibility
2. Uncertainty
3. Control assessment
4. Monitoring

1. **Objectives Practicality and feasibility**

It should consider as the significance of contribution of the element to the practicality and feasibility of setting the objectives that could be established for the examined process which influences safety, quality and environmental performance.

I.e. contract review > objective: understand contract requirements-customer needs.

Rank 1: important Rank 2: average Rank 3: less important

2. **Uncertainty to achieve objectives**

It should be considered the significance of the level of risk in order to achieve for set objectives.

I.e. contract review > objective: understand contract requirements-customer needs > Inexperienced personnel review and lack of understanding requirements.

Rank 1: important Rank 2: average Rank 3: less important

3. **Level of controls**

It should be considered the significance of the level of existing controls in order to assess the risk for set objectives.

I.e. contract review > objective: understand contract requirements-customer needs > risks: Inexperienced personnel review and lack of understanding requirements > controls: Training, procedures.

Rank 1: important Rank 2: average Rank 3: less important

The highest the level of the controls the lowest is the risk.

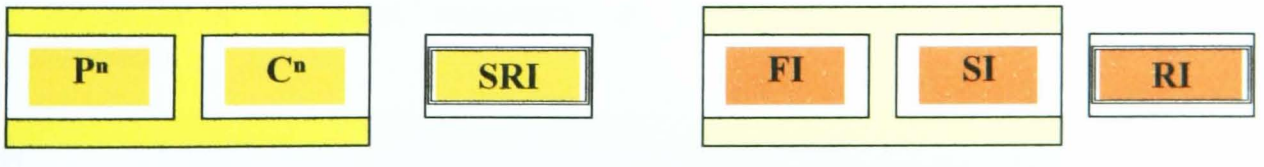
4. **Monitoring**

It should be considered the significance of the level of measurable ability in order to assess the results for set objectives.

I.e. contract review > objective: understand contract requirements-customer needs > risks: Inexperienced personnel review and lack of understanding requirements > controls: Training, procedures > Meet contract requirements performance.

Rank 1: important Rank 2: average Rank 3: above average could be easily quantified

The management system elements above weighted under the above mentioned criteria and an assignment of weights to management categories carried out for Safety, Quality, Environmental and OH&S management systems. The results compared with those ranked by the core elements and results evaluated for consistency. Confidence level is also considered in this assessment and comparison process.



5.5 Success Factors

Success factors are factors that measure the competitiveness of the implemented ship management system by the risk ranking factor to a considerable extent. The identification of the success factors in the risk based management system helps me to measure and rank the overall risk based management performance as far as regard actions should be taken so that limited risk management resources to be directed for best possible effect and to identify the level of the weak management areas in order to set priorities in management review. Success factors can be also applied as the basis for risk management models presented above, such as value trees and models of the analytic hierarchy process.

This evaluation is applied on the survey No 3 part 2 and the determination of actions should be carried out during the assessment and the response proved that by that continuous improvement achieved. The identification of success factors was focused on the implemented management systems and its ranking and evaluation of the deviation of pre assigned figures in the presented above risk based core elements management structure.

Five interrelated success factors were identified during the discussions for Ship's safety, Environmental care, Quality of services and occupational health and risk index. The result reflecting risk management evaluation of the core elements for all departments of participants in the surveys and case studies were not on the same conceptual level, but they reflect the points that were specifically emphasized during the surveys. The success factors determined as a percentage to the conformity to the areas of investigation in an approximate order of importance. The level of 40% for core elements and 30% for core elements subcategories considered as initially adequate predefined levels at a first stage for testing the ranking and relative relationship of core elements and risk index. A total success factor considered as the result emanated by the formula of (RI-RRI)/RRI=SI. The conclusions created by the success rating which calculated based of the identified "Areas for Improvement" standard deviation in the above mentioned survey based on the principal that Safety, Quality, Environmental and OH&S IASMAR audit results identify weak areas and by adjustment improving performance goals for operational objectives. In addition, companies may also seek operational safety, quality and environmental improvements beyond minimum compliance with success factors levels. For the ship managers this project proposes that a consistent ranking system can improve a company's QSEM performance by comparison with success factors and success rating. The IASMAR tool help to create a more objective rating system, to focus on areas needed improvement, to encourage company's risk management improvement, and facilitate a common measure of Safety, Quality and Environmental effectiveness.

5.6 Analysing documents and questionnaires

Based on the above plan the relative literature consisted of books, documents, data and software was collected based on which the necessary resources used for project's realization. The material gathered, analysed and assessed as relative to my project was:

I followed the text of the ISM Code 2002 from IMO publishing copy which I am attaching to the appendices for easy reference of the clauses. Also I have studied during my Auditor/ Lead Auditor courses the standards of ISO 9001:2000, ISO 14001: 2004, and OHSAS 18001:2000 with focus of interrelation and common elements. Additionally I have studied the IMO guidelines for formal safety assessment for the use of the rule making process MSC/circ 1023, MEPC/circ 392 ANNEX. Additional studies I have followed by American Bureau of Shipping for risk evaluation for the classification of marine related facilities for methods and techniques used for risk assessment and management. Analytical presentation of the books, documents and relative data presented in the specific area as Bibliography in this report. Based on the plan the questionnaires collected for the Survey No 1 at first stage by the assistance and efforts made by my colleagues for completion in order to get the most accurate reply for the data needed from the survey. The first 16 questionnaires collected by e mail reply and the rest 14 completed in the style of interview with each one of the participants. A part of 8 questionnaires partially fulfilled by the participants and finally completed as much as possible in the style of interview and results were included in the results where applicable. During the period of survey telephone explanations and clarification made to the participants for proper amendment and completion of the questionnaire. The material of these questionnaires collected and processed to retrieve project survey's conclusions.
In the second Survey 2 which was a case study for different types of ships things were much easier and almost all active participants of the first survey participated in Survey 2 and 32 replies collected. Beside the case studies easily carried out a special attention was given to the collected data and its qualitative characteristics. In order to avoid extraordinary approaches I have correlated the level of confidence in order first to make participants more cautious to their estimates and to cutting down estimates to a more reliable approach and secondly to correlate level of confidence with participants characteristics and area of implementation. This verified in the detailed analysis of the results. In survey No 3 the companies participated were selected by the results of Survey 1 and 2, the type of managed ships and the management systems implemented to their companies. Totally 15 companies participated in the first stage of Survey 3 for which evaluation of criteria made in order to collect a representative and reliable data to score weighting. Finally the system implemented and relative auditing protocols created for 3 companies where the evaluation of improvement made for the succession of results. The companies selected have major multi or single type fleet of the majority of the ships related to my project. The results of my project and the benefits of the auditing system have been proved beside the problems I have faced to convert questions on my questionnaires in the relative surveys to variables and numbers for the purpose of the analysis of the results. The important participation of my colleagues in my company consisted of long experienced Masters and Engineers assisted me in the difficult clarification of criticality of shipping and shipboard activities and creation of lengthily risk scenarios with rational preventive and mitigating strategy needed for proper management and minimisation of losses. My role as managing director gave me the opportunity to deal, handle, coordinate and solve a wide variety of cases and aspects of safety, quality, environmental and occupational health management, which have provided inspiration and knowledge to my colleagues for the

proposed approach of the research described above. My duty to coordinate with my colleagues for day to day operational and technical decisions and solutions improved my cooperation and leadership with others in difficulties and disputes raised. Definition and a clear set of elements and assessment criteria for a more objective auditing system to encouraging improvement, particularly beyond minimum compliance levels and a common measurement of SQEHMS system effectiveness were the main variables set in my project. The result of my project succeeded an effective QSEM management and auditing system which is improving a company's compliance with the Quality, Safety and Environmental standards set by company and creates a mechanism for continuing improvement.

5.7 Writing the report and formulation of conclusions

Further to the analysis and statistical risk monitoring of the results I started to write down my project's report. My project has agreed to be presented by one document that demonstrates achievement and is integrated with critical commentary in the area of 35.000 words for the research and development product. Initially I have created the basic form of my report and then I tried to present results created by my project and methodology followed. I have amended and corrected the context of my report several times until the formulation of final report. Because I am distance learner in Athens and the University based in London I received a great academic support by my advisor and project's consultant with whom several joint meeting enables me to keep the right track in my project's formulation and findings. In the final stage based on the results and achievements of my research in relation to my integrated auditing system and the proposals for continuous improvement by predicting grey areas which considered at highest risk level, I have formulated the results and conclusions as well as potential areas of my project which could be developed and researched further. The realisation of my project proved my achieved great depth of knowledge during the period of research by reading latest publication in risk management of various applications and the additional skills I received in training seminars enables me to work at latest ideas and current limits of theoretical and research understanding. This assisted me to evaluate properly the results and present the conclusions including future research. My awareness of ethical dilemmas which arises in my research modified the presented elements and data of my research by isolating data which could expose or lead to extreme results since I have treated subjective opinions with high level of responsibility and professional practice.

So with this way I have concluded the research of my project and I would like to thank all my colleagues and partners to this adventure who assisted my effort to achieve the results of this complicated combination of standards core elements with risk management and the representatives of the participants who patiently and creatively took part in this research which finally enabled me to conclude my doctoral research which was highly desirable. I strongly believe that my involvement in this subject will improve my perspective and participation in relative initiatives and programmes keeping always in mind the commitments undertook during the realisation of my project.

CHAPTER SIX: PROJECT FINDINGS

The research models were constructed using the data described in Chapter 5 for the relevant surveys carried out. The data collected in the 3 surveys for the research represents a number of participants from ship related companies and analyzed as follows:

Survey 1 Rev.1 and 2

Questionnaires distributed in 53 companies totally from which 50 considered as the nominal sample. The completed responses I received finally were 30 replies and 8 incomplete which were used for data where applicable.

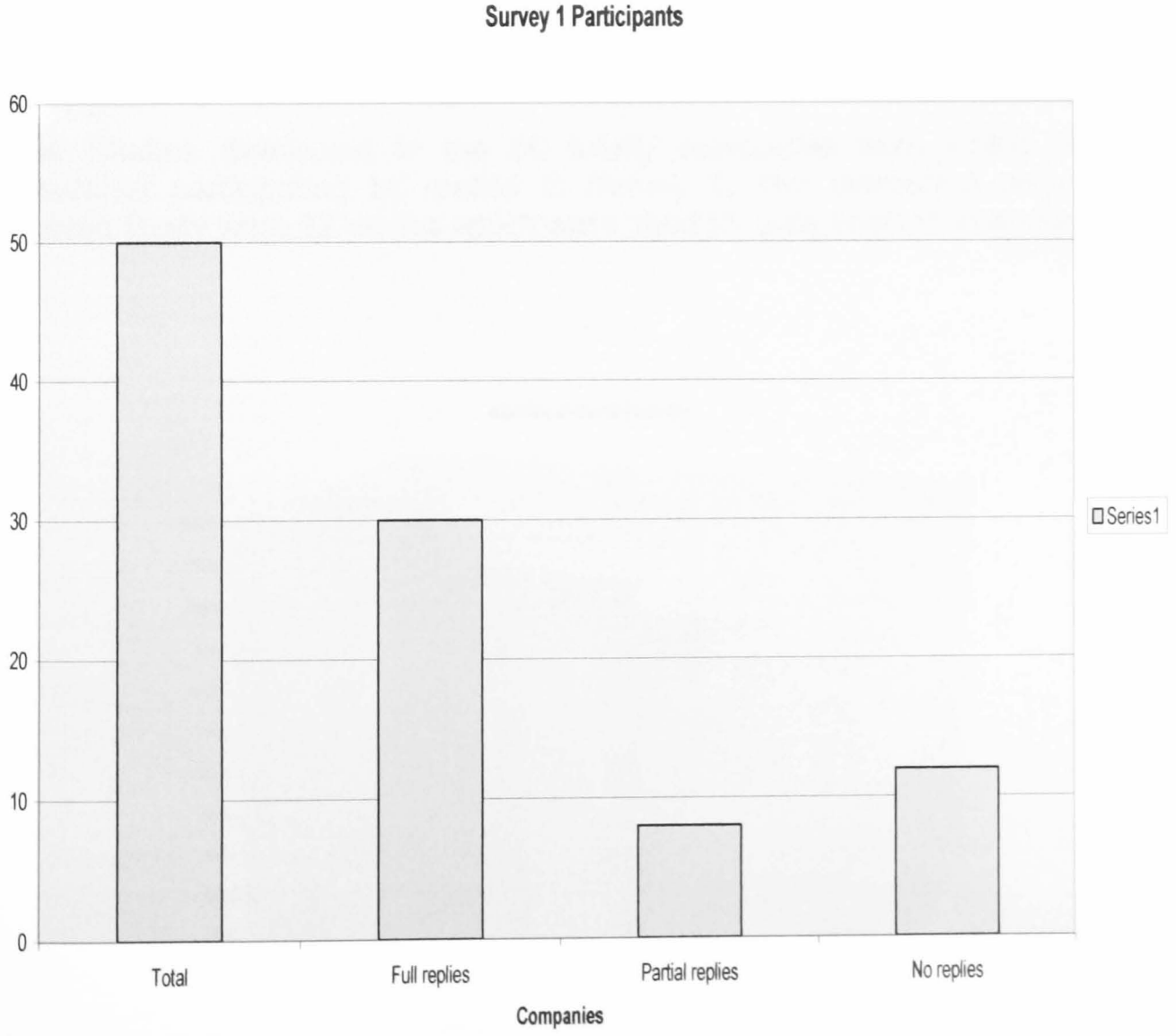


Table 6.1 Survey 1 Participant Companies

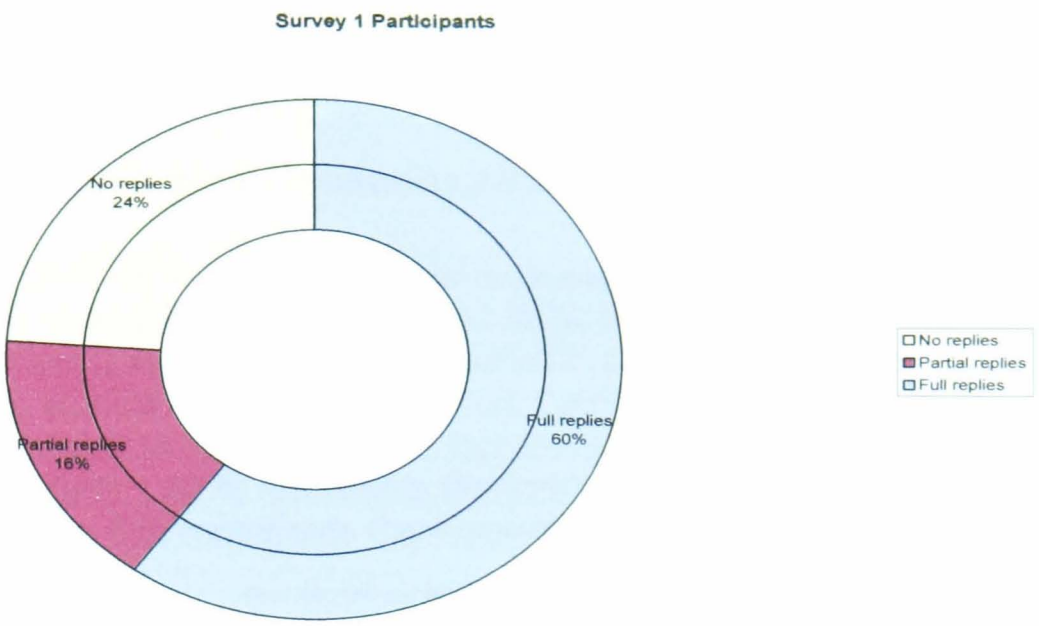


Table 6.2 Survey 1 Participant Companies percentage replies

These companies' participants represent approximately a fleet of 1.6 million tons DWT in total capacity in eight different types of ships. This participants sample represents world wide trading fleet with various flags and classification societies.

Survey 2

Case Studies distributed in the 50 totally companies from which 38 were considered participating by replies in Survey 1. The completed responses I received finally were 32 replies which were used for data evaluation and analysis.

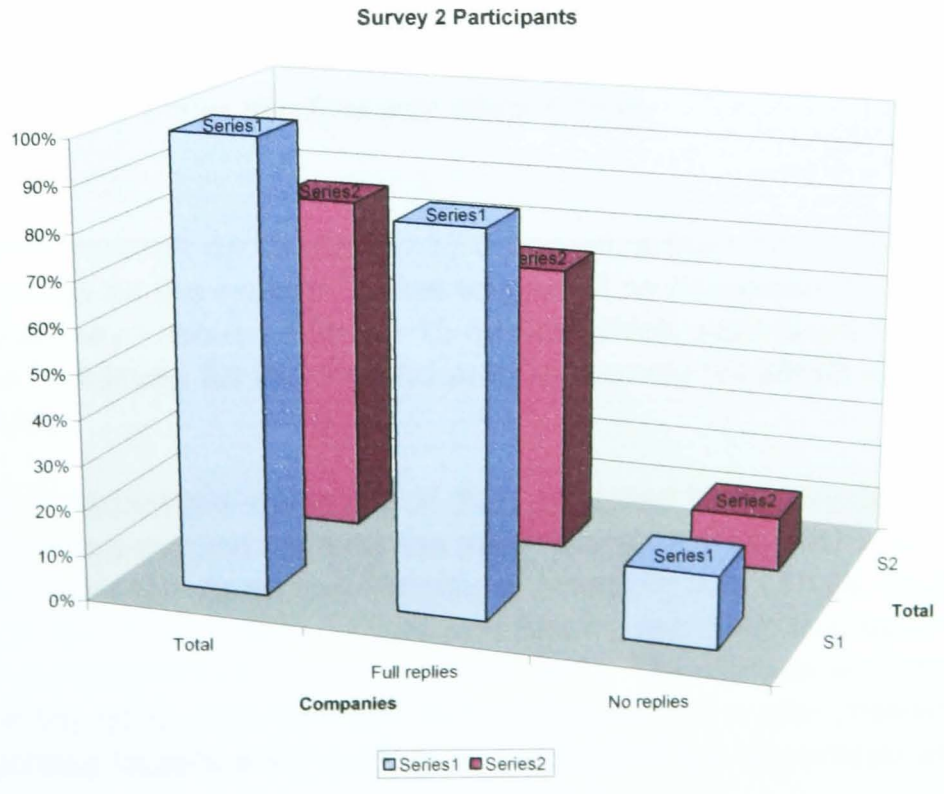


Table 6.3 Survey 2 Participant Companies percentage replies

These companies' participants represent approximately a group of 32 companies or 64 % of total 50 participants in Survey 1 and 85 % of the replies received in Survey 1. This Survey 2 represents 8 case studies in 40 companies/ship's type. For a total 40 case studies 23 % represents Bulk Carriers, 15 % represents Oil Tankers, , 15 % represents Reefers, , 13 % represents Containers, , 10 % represents Gas Carriers, , 10 % represents General Cargo, 8 % represents Chemical Tankers and 8 % represents Car Carriers.

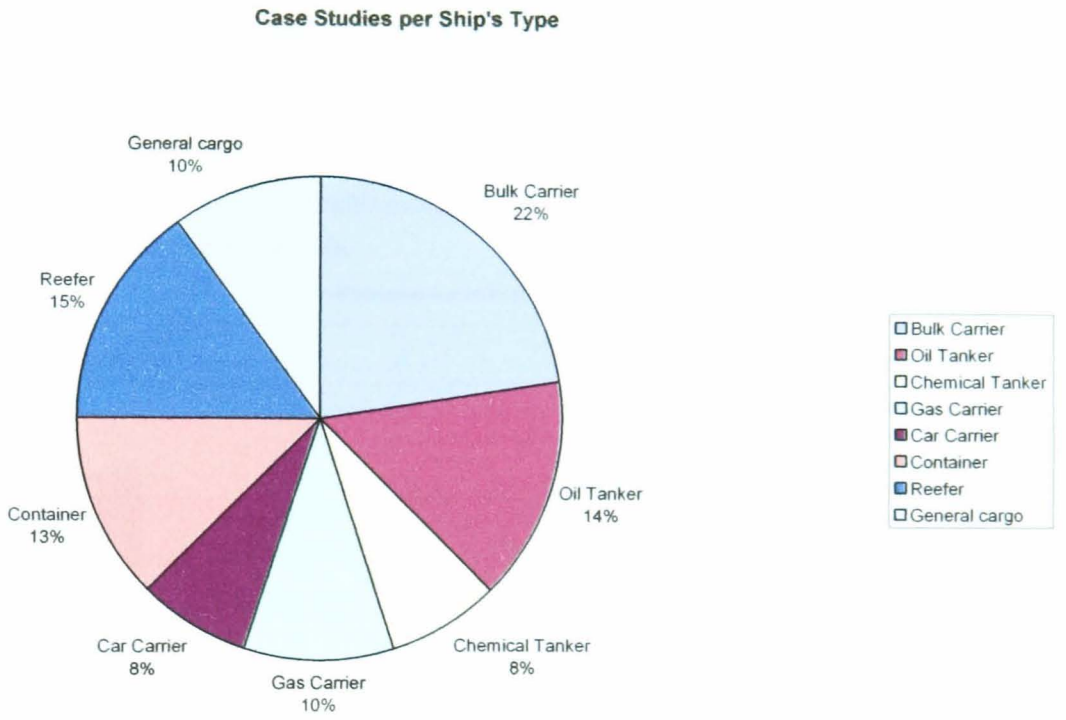


Table 6.4 Survey 2 Case studies per Ship's type

Survey 3

Auditing questionnaires distributed in 15 companies from 50 totally participated which considered as the nominal value sample. The completed responses for the first auditing survey I received finally 15 replies which were used for data process and 5 replies I received for the second auditing survey for which also statistical analysis made.

This Chapter presents the summary of data collected from previous research data, the 3 Surveys carried out and the data available from IMO and Classification Societies American Bureau of Shipping and Lloyds Register mainly contributing in this information. Tables and figures are used to present the participants' characteristics in a quantifiable form. The various analysis performed on the data collected from the participant's are also presented. The results of success factors and conditions' verification are discussed and analyzed.

6.1 Survey 1

General Characteristics

The 53 participants initially determined had a wide variety of ship related activities the majority of which was the ship management in a diversified fleet of all types of ships.
The profile of participants determined in Section 1 of the survey and analyzed as follow:

Section 1

Part 1.1 Profiles

The majority of the participants were ship management companies owning various types of ships 34 participants followed by charterers who were also operators and partially owners in the number of 7 participants. Classification societies, consultants and insurance companies for both hull and machinery and protection and indemnity were participated in a limited number due mainly to limited use of data and ethical constraints but were considered representative sample needed for global perception.

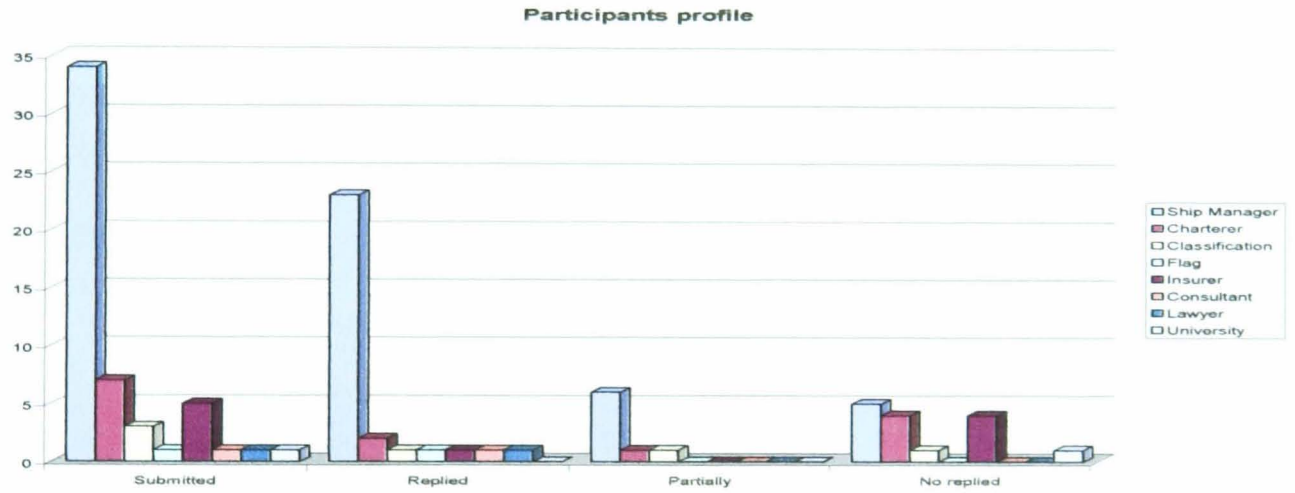


Table 6.5 Survey 1 Section 1 Part 1.1 Profile

1.1 Participants profile					
	Type	Submitted	Replied	Partially	No replied
A1	Ship Manager	34	23	6	5
A2	Charterer	7	2	1	4
A3	Classification	3	1	1	1
A4	Flag	1	1	0	0
A5	Insurer	5	1	0	4
A6	Consultant	1	1	0	0
A7	Lawyer	1	1	0	0
A8	University	1	0	0	1
	Total	53	30	8	15

Table 6.6 Survey 1 Section 1 Part 1.1 Profile distribution

The replies received were representative for the research sample and presented in the above diagram.

Part 1.2 Positions

The participant's position were mainly from operations and technical background in ship management companies and strengthen the sample since there the majority of incidents dealt by such responsibilities. The participants have the background with distinctive nature of people in action and on action which was very encouraging in the significant contribution of participants. Their ability to plan and manage shipping and shipboard activities and by their actions to involve every one ashore and onboard gave additional value to my research.

1.2 Positions		
	Position	No
A1	Managing Director	4
A2	Operations Manager	10
A3	Port Captain	6
A4	Technical Manager	4
A5	Superintendent	7
A6	Manager	7
	Total	38

Table 6.7 Survey 1 Section 1 Part 1.2 Positions distribution

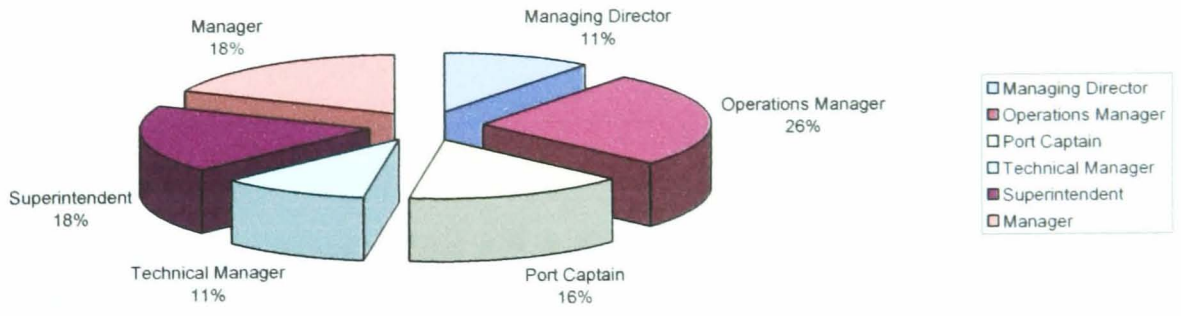


Table 6.8 Survey 1 Section 1 Part 1.2 Positions

Part 1.3 Additional Duties

Additional duties were evaluated in the research sample to determine the relevance with incident identification and record keeping by the participants which has given a reliable and quantifiable dimension to the qualitative subjective estimations. Additional duties of Designated Person and Company's Representative had the majority of the participants as well as management's and media representatives which are the most neuralgic positions during a particular

incident or loss. It is important also that people with such roles and responsibilities interested in participating to this survey.

1.3 Additional duties		
	Additional Duties	No
A1	Designated Person Ashore	23
A2	Management Representative	10
A3	Company's Representative	17
A4	Media Representative	6
	Total	56

Table 6.9 Survey 1 Section 1 Part 1.3 Additional Duties distribution

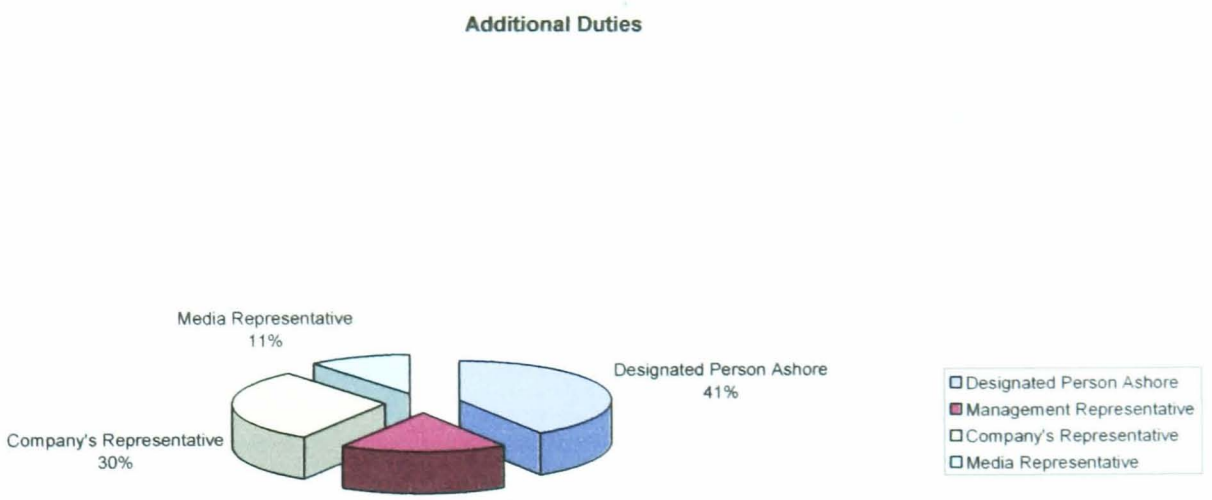


Table 6.10 Survey 1 Section 1 Part 1.3 Additional Duties

Ship management companies were very supportive and had great interest for the project and encouraged participation and awareness to their managers and employees.

Part 1.4 Experiences

The participants in the survey seem to have been in the shipping profession for long period of time which is a combination for many of them working on board as Masters or Engineers and ashore with present duties. The period of these intervals is not determined in this survey but the importance is that the qualified and experienced sea going Masters or Engineers have been mainly employed ashore for head office roles and responsibilities. This gives additional value to the results since data emanated from some of the best staff servicing for a period also at sea.

1.4 Experience		
	Experience	
A1	Less than 2 yrs	1
A2	2-5 years	2
A3	5-10 years	11
A4	More than 10 years	24
	Total	38

Table 6.11 Survey 1 Section 1 Part 1.4 Experience distribution

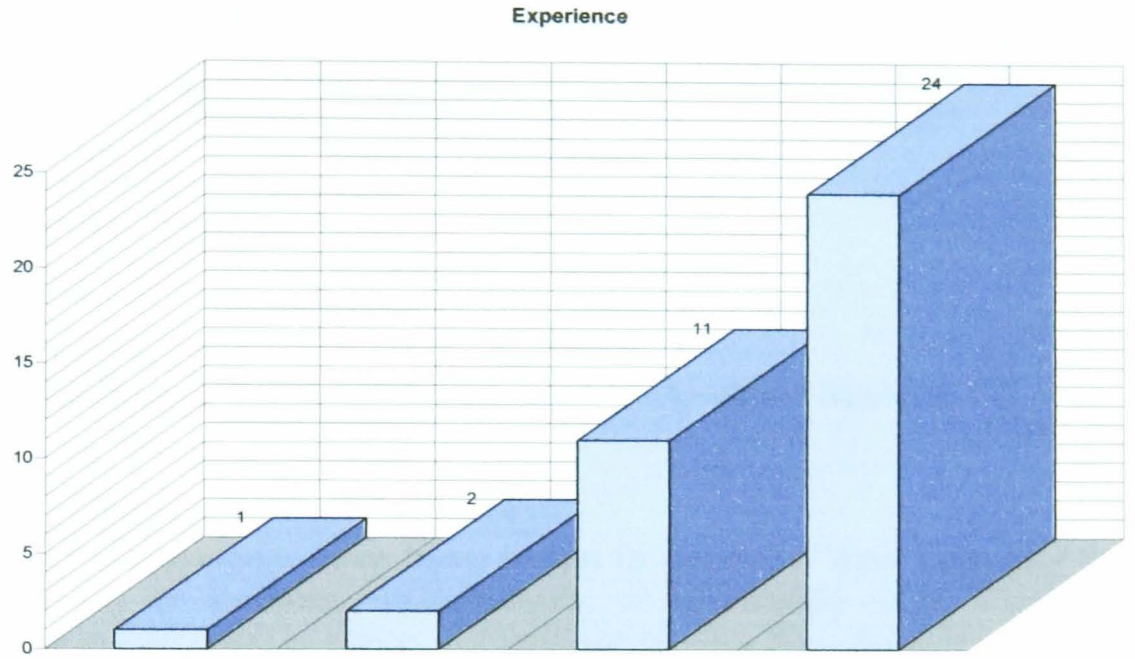


Table 6.12 Survey 1 Section 1 Part 1.4 Experience

Part 1.5 Implemented Management Systems

Safety management system ISM is compulsory for ship managers that's why appeared fully implemented where quality and environmental management which are voluntarily proved to have limited implementation in the maritime industry. This proves also the limited awareness the participants had in risk management methodology and planning which mainly and clearly identified in management systems conforming ISO 14001 and OHSAS 18001.

1.5 Management System		
	Management System	No
A1	ISM International Safety Management	31
A2	QMS Quality Management system	14
A3	EMS Environmental Management System	3
A4	OHSAS Occupational Health and Safety	2
A5	RMS Risk Management System	2
	Total	52

Table 6.13 Survey 1 Section 1 Part 1.5 Management System distribution

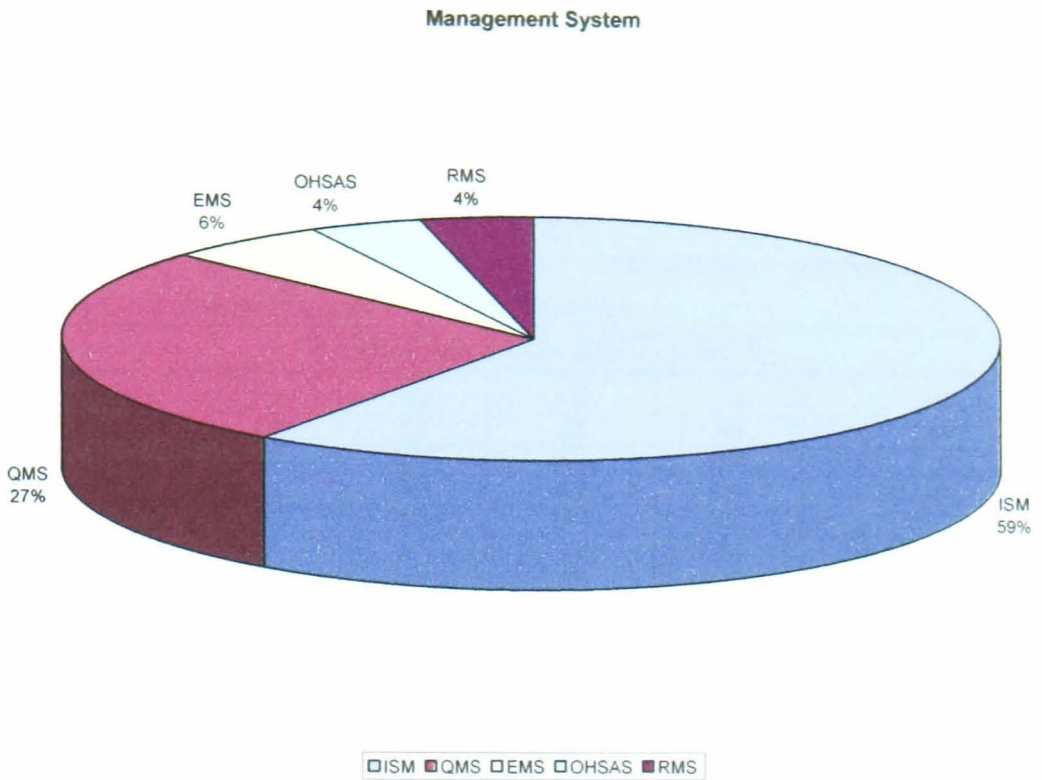


Table 6.14 Survey 1 Section 1 Part 1.5 Management System

Part 1.6 Management of ships

In this part participants have been asked to declare if their company manages ships directly or indirectly, commercially or technically or otherwise such as insurance in flag wise in cases of bareboat or long term time charter. This is an important discrimination for collected data since sample is divided in two groups, the first which is directly involved in the incident and getting responsibility to manage and the second which is supporting the first subject to terms and conditions to mitigate consequences.

Ships	Yes	No
No	30	8

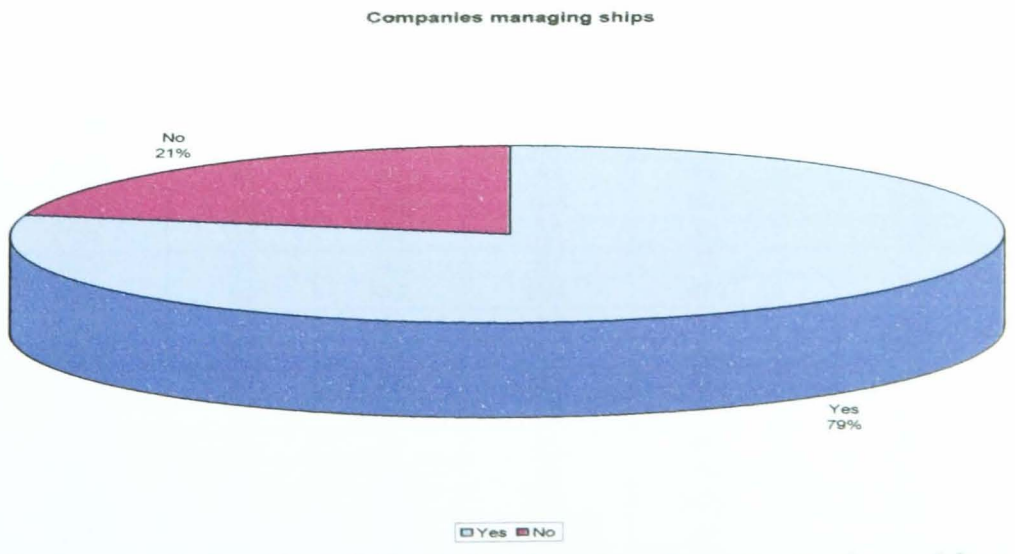


Table 6.15 Survey 1 Section 1 Part 1.6 Companies managing ships

Summary

By summarizing section 1 the following results emanated from the analysis of data collected and presented in the Table below. This table is used also in the research and relative numbers remain representing a particular company participated in the research. Codes in companies mean type of company and relative number i.e. C1 means consultant, U1 means university, SM1 means ship-management company, I1 means insurance company, CH1 means charterer and CL1 means classification society.

SUMMARY OF SECTION 1

No	Company	1.1	1.2	1.3	1.4	1.5	1.6
1	C1	A6	A1	A3	A4	A2	A2
2	U1	A8	N/A	N/A	N/A	N/A	N/A
3	I1	A5	N/A	N/A	N/A	N/A	N/A
4	SM1	N/A	N/A	N/A	N/A	N/A	N/A
5	SM2	A1	A1	A2	A4	A1,A2,A3,A4,A5	A1
6	SM3	A1	A2	A1	A2	A1	A1
7	I2	A5	N/A	N/A	N/A	N/A	N/A
8	SM4	A1	A5	A1	A4	A1	A1
9	CH1	A2	N/A	N/A	N/A	N/A	N/A
10	SM5	A1	A3	A2	A4	A1,A2	A1
11	C2	A6	N/A	N/A	N/A	N/A	N/A
12	SM6	A1	A1	A1,A2,A4	A3	A1,A2	A1
13	SM7	A1	A2	A1,A2	A3	A1	A1
14	SM8	A1	A3	A1,A2	A4	A1,A2,A3	A1
15	SM9	A1	A3	A1,A3,A4	A3	A1	A1
16	SM10	A1	A5	A1	A3	A1	A1
17	SM11	A1	A2	A1,A2	A3	A1,A2	A1
18	SM12	A1	A4	A1	A4	A1	A1
19	CH2	A2	N/A	N/A	N/A	N/A	N/A
20	SM13	A1	A4	A1	A4	A1	A1
21	SM14	A1	A2	A1	A4	A1	A1
22	SM15	A1	A5	A1	A4	A1	A1
23	L1	A7	A6	A3	A4	A2	A2
24	CH3	A2	N/A	N/A	N/A	N/A	N/A
25	CL1	A3	A6	A3	A4	A2	A2
26	SM16	A1	A5	A1	A3	A1	A1
27	FL1	A4	A6	A3	A3	A2	A2
28	SM17	A1	N/A	N/A	N/A	N/A	N/A
29	SM18	A1	A1	A1,A3,A4	A4	A1	A1
30	CL2	A3	N/A	N/A	N/A	N/A	N/A
31	SM19	A1	A2	A2,A3,A4	A4	A1,A2	A1
32	SM20	A1	A2	A3	A4	A1	A1
33	SM21	A1	N/A	N/A	N/A	N/A	N/A
34	I3	A5	A6	A3	A3	A5	A2
35	CH4	A2	A3	A2,A3,A4	A4	A1	A1
36	SM22	A1	A4	A1,A3	A4	A1	A1
37	SM23	A1	A2	A1,A2,A3	A4	A1	A1
38	SM24	A1	A5	A1	A3	A1	A1
39	CL3	A3	A6	A3	A4	A2	A2
40	SM25	A1	A5	A1	A4	A1	A1
41	SM26	A1	N/A	N/A	N/A	N/A	N/A
42	CH5	A2	A6	A3	A3	A2	A2
43	SM27	A1	A3	A1	A2	A1	A1
44	CH6	A2	N/A	N/A	N/A	N/A	N/A
45	CH7	A2	A6	A3	A3	A2	A2
46	SM28	A1	A3	A1	A4	A1	A1
47	SM29	A1	A4	A1	A1	A1	A1
48	SM30	A1	A2	A1	A4	A1	A1
49	SM31	A1	A5	A1	A4	A1	A1
50	SM32	A1	A2	A3	A4	A1	A1
51	SM33	A1	N/A	N/A	N/A	N/A	N/A
52	SM34	A1	A2	A2,A3,A4	A4	A1	A1
53	I4	A5	N/A	N/A	N/A	N/A	N/A

Table 6.16 Summary Section 1

Section 2

Part 2.1 Fleet

The majority of the participants were ship management companies owning various types of ships. The majority of owned ships were bulk carriers followed by tankers and containers but also a substantial sample of the rest types of ships were participated in the project.

2.1 Fleet		
	Fleet	No
A1	Below 2 ships	0
A2	2-5 Ships	10
A3	5-10 Ships	14
A4	Above 10 Ships	6
	Total	30

Table 6.17 Survey 1 Section 2 Part 2.1 Fleet size distribution

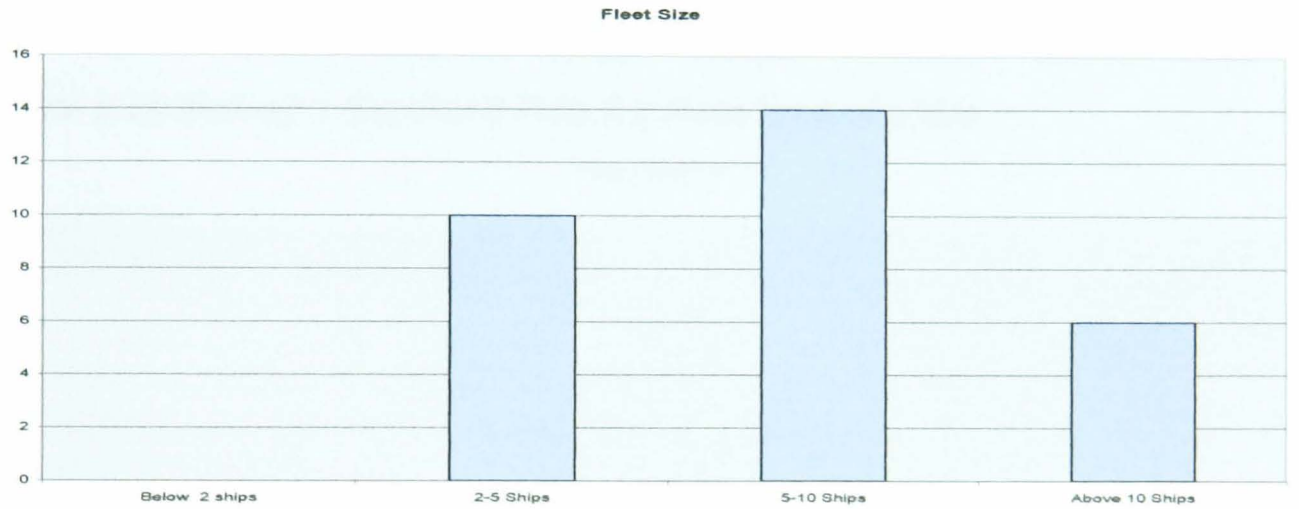


Table 6.18 Survey 1 Section 2 Part 2.1 Fleet size

Part 2.2Type of ships

This created a balanced profile of almost all types' of ocean-going ships and gave the potential for a good sample of views and opinions to be obtained. In order to assess the interest of risk involvement to shipping activities, the size and the type of the fleet was considered important. The types of the ships owned by the companies' participants the survey figured below.

2.2 Type of ships			
	Fleet	Companies	Ships
A1	BC	20	106
A2	Oil Tankers	12	61
A3	Chemical Tankers	3	5
A4	Gas Carriers	4	9
A5	Car Carriers	3	5
A6	General Cargo	4	6
A7	Reefer	6	10
A8	Container	5	42
	Total	57	244

Table 6.19 Survey 1 Section 2 Part 2.2 Type of ships distribution

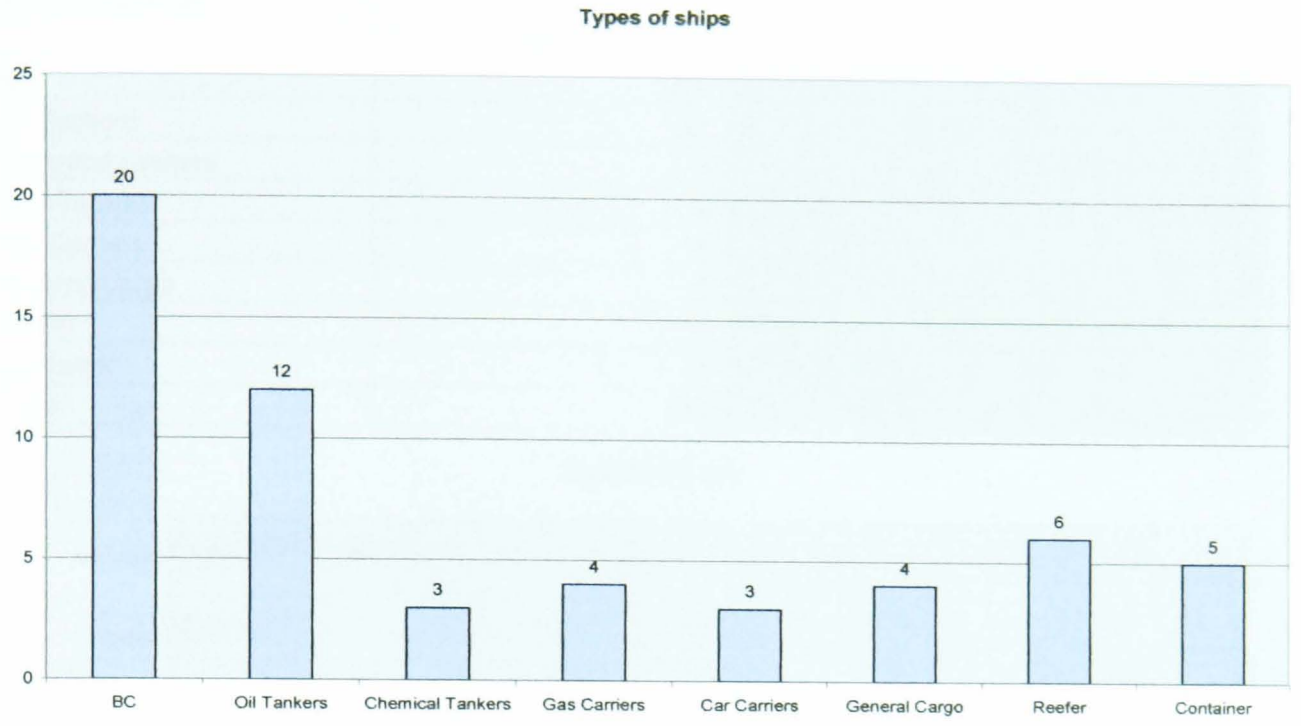


Table 6.20 Survey 1 Section 2 Part 2.2 Fleet type of ships

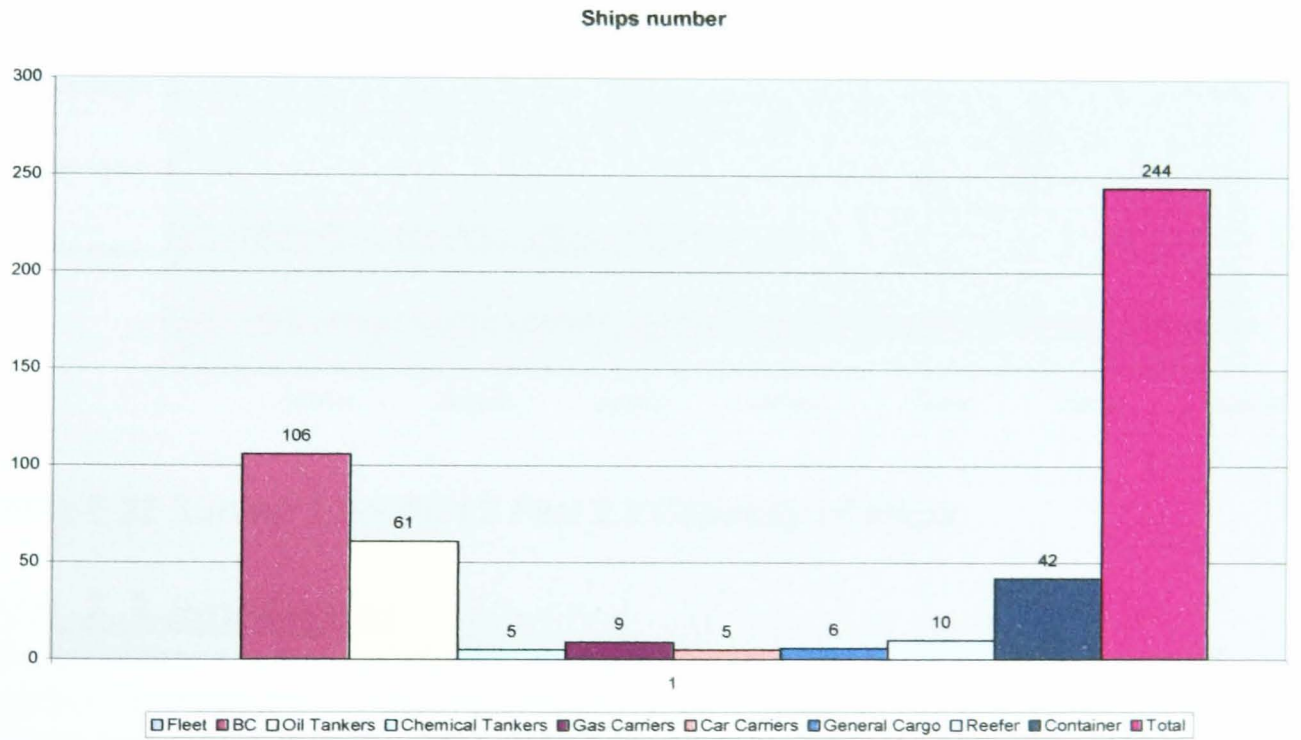


Table 6.21 Survey 1 Section 2 Part 2.2 Number of ships

The number and the capacity of the ships owned by the participants in tones DWT figured in Table below and representing the typical ships for risk assessment since the diversified distribution in many different types and sizes providing confidence for a good cross section of views considered. The total capacity of ships managed by the companies participants numbered in the amount of about 12 millions of tones deadweight and 244 ships which ensures that responses were being received from staff of shipping companies participating in the research are coming from a variety of fleets with different sizes and the sample used in the research is more balanced and reliable.

2.2 Type of ships		
	Ships	DWT
BC	106	6,510,000
Oil Tankers	61	3,651,000
Chemical Tankers	5	67,000
Gas Carriers	9	37,000
Car Carriers	5	125,500
General Cargo	6	66,500
Reefer	10	158,500
Container	42	1,306,500
Total	244	11,922,000

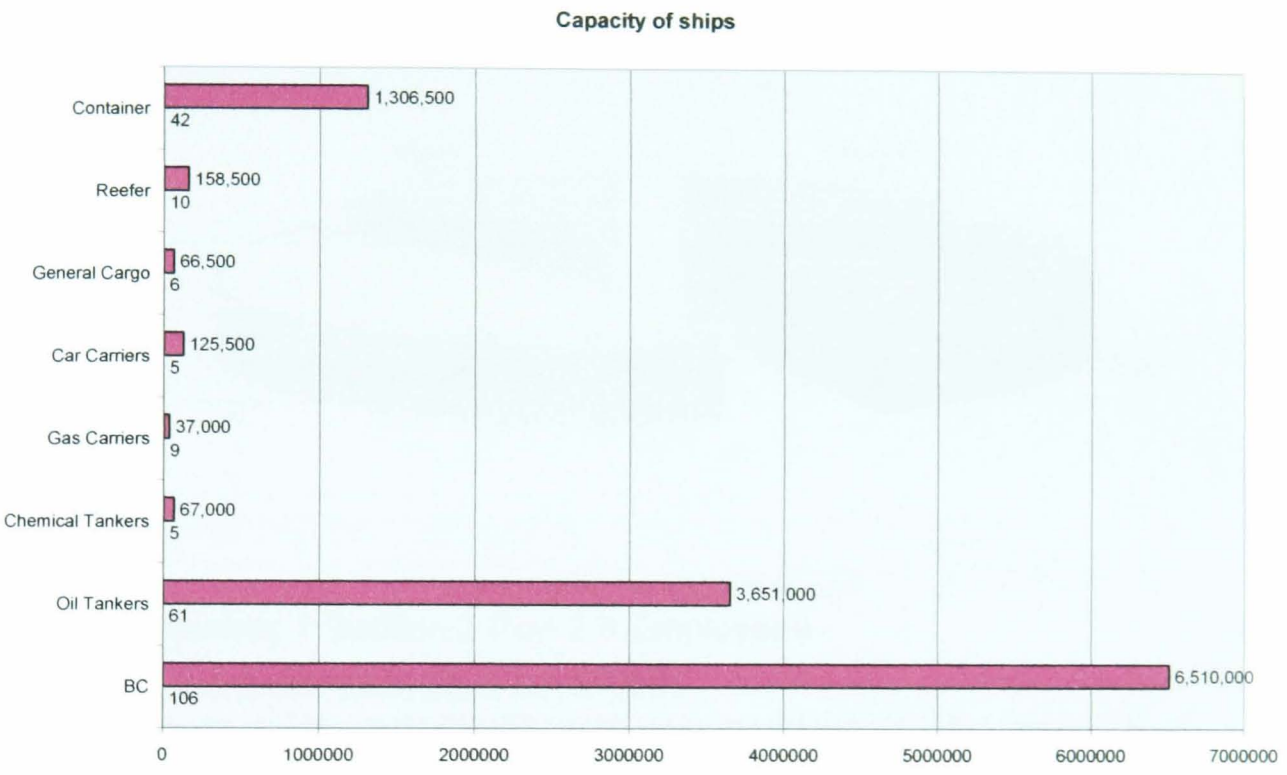


Table 6.22 Survey 1 Section 2 Part 2.2 Capacity of ships

Part 2.3 Employees

The employees in the companies managing ships considered using a limited number of employees which traditionally also related to the principals. From the results it seems that companies participating had normal distribution of personnel providing the concept that the most skillful and capable personnel which servicing also onboard employed ashore. So the results of the study created from capable and best available personnel. The 13% of the participant companies had personnel between 5-10 persons, 30% had personnel 10-20 persons, and 43% had personnel 20-50 and 13 % over 50 persons. It seems that the employees are directly relative to the size of the managed fleet. The diversification of the participated companies in size of employees gave me confidence that the research results of the sample was from a good variety of size of companies participated

2.3 Employees			
	Employees		
A1	Persons 5-10	4	13%
A2	Persons 10-20	9	30%
A3	Persons 20-50	13	43%
A4	Over 50	4	13%
	Total	30	100%

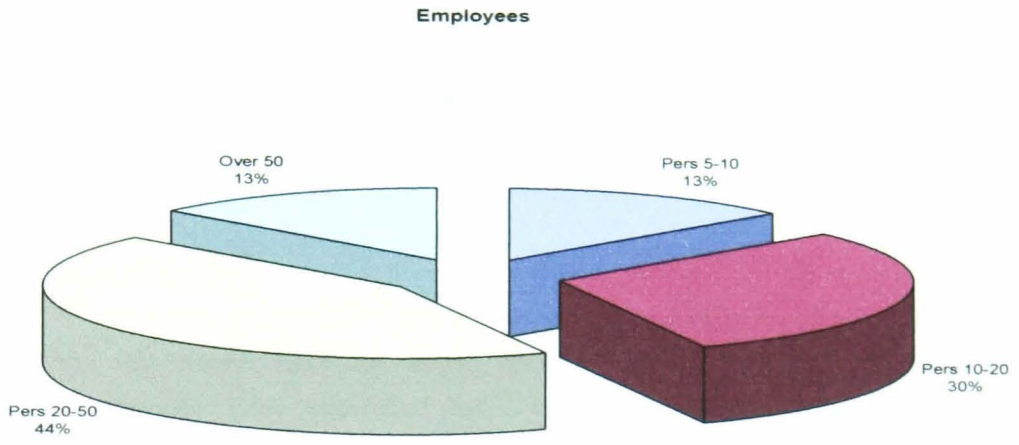


Table 6.23 Survey 1 Section 2 Part 2.3 Employees

Part 2.4 Employees involvement

The companies of the participants were also evaluated for the capability of employee's involvement in various implemented management systems. The majority seems well structured with adequate personnel to follow up and involve risk perception to their business.

The personnel of the ship management companies was concluded that in majority have been directly involved in the preparation of implemented management system procedures and instructions which mainly prepared by company's personnel with assistance of external consultant and company's designated person. From the companies participated a part of 13% is not involved in the preparation of implemented management system but the 87 % which is the vast majority declared that the personnel is directly involved in preparation on management system documentation. This is very important because by that involvement employees are aware of the commitments, requirements and parameters to meet objectives and performance targets.

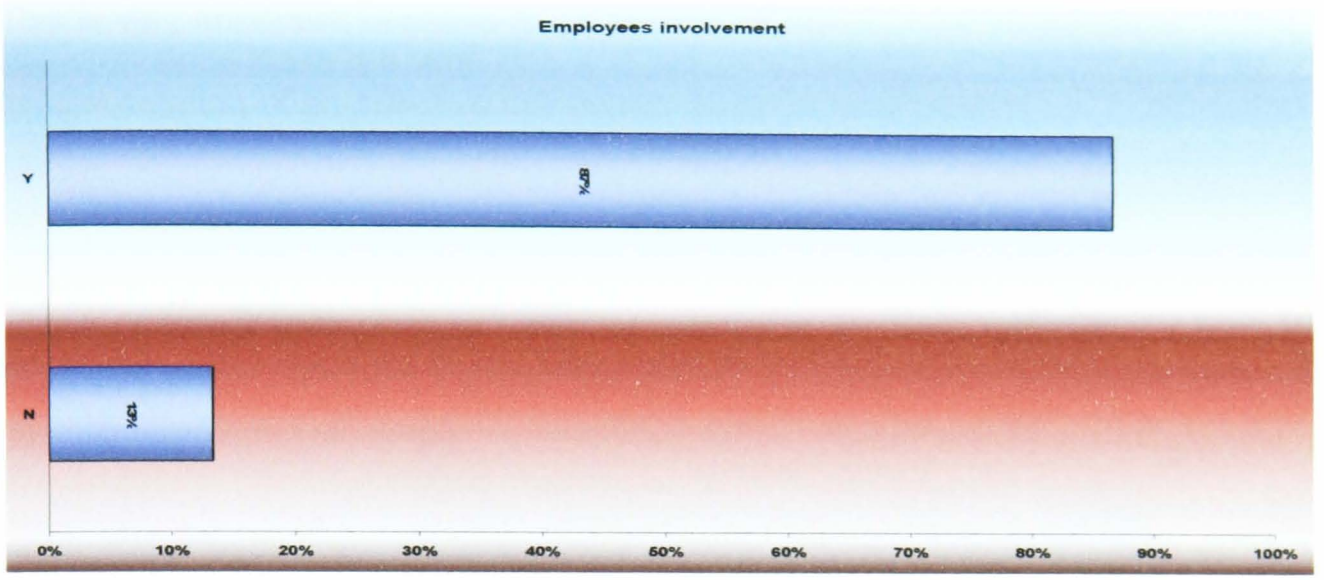


Table 6.24 Survey 1 Section 2 Part 2.4 Employees involvement

Part 2.5 Assessment

The majority participants declared that their company within ship management duties set specific standards and perform assessments in areas of safety and environmental protection and quality if such management system is applicable. The 53 % replied that their company set standards and perform assessments in areas needed pertinent to the implemented management system. The 47% who replied negative most probably consider that there is no further need for that since ISM has been prepared long ago and no other management system is under implementation.

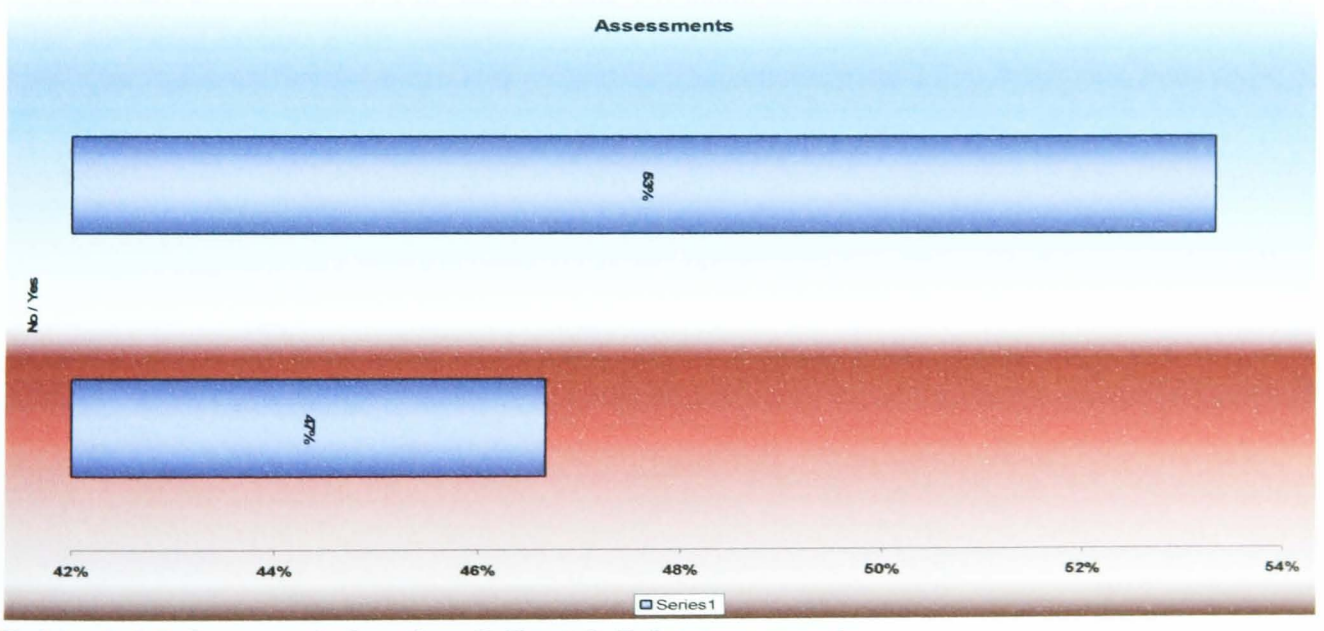


Table 6.25 Survey 1 Section 2 Part 2.5 Assessments

Part 2.6 Risk Management System

The companies participated have a limited awareness for implementing a Risk Management System. Only 20 % of the participants are aware of the procedure for establishing a risk management system and its emanated documentation, reviewing and monitoring. The rest 80 % declares that there is no any particular definition or commitment for the establishment of a risk management system.

This is very important because gives special attention to the scope of my research since there is a wide gap and lack of knowledge and commitment for implementation of an effective risk based management system.

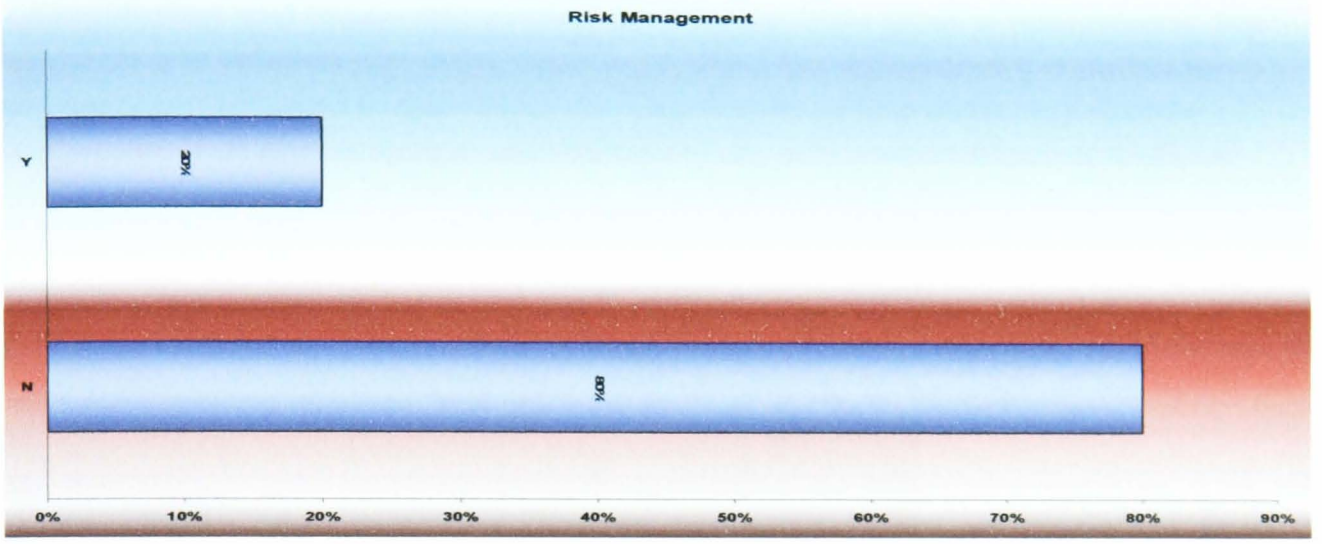


Table 6.26 Survey 1 Section 2 Part 2.6 Risk Management

Part 2.7 Training

The personnel ashore and onboard have received continuous and proper training covering all sensitive areas of safety, environmental protection and quality where applicable , which is a good resource for the perception of implied conditions and developing the cross section of views which could be obtained from different group of employees in a variety of shipping activities. Training is the cornerstone of management and the 87 % is a very good level which ensures that participants are well aware of the latest conditions and requirements and only 17% declared poor training within their duties.

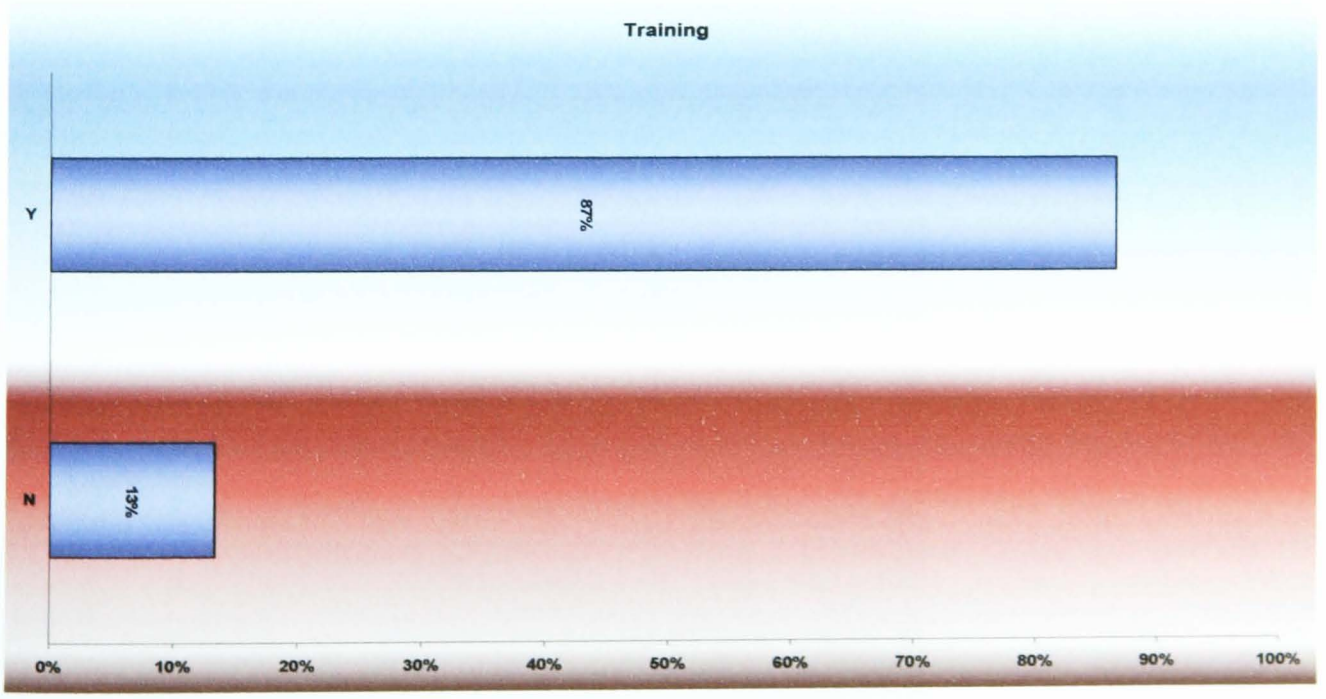


Table 6.27 Survey 1 Section 2 Part 2.7 Training

Summary

By summarizing section 2 the following results emanated from the analysis of data collected and presented in the Table below. This table is used also in the research and relative numbers have been used for representing a particular company participated in the research. The results of this section gives the confidence that the sample is representative by any means which should be additionally assessed to the section 1. The Companies which have been selected to participate in this research had been screened so as the cross section of views to represent the spectrum of shipping industry by the size and type and finally the quality of the employees thing which with the results seems to have been achieved.

Summary of parts 2.4 & 2.5 & 2.6 & 2.7				
Items	2.4	2.5	2.6	2.7
SM2	Y	Y	Y	Y
SM3	Y	N	N	Y
SM4	Y	Y	N	Y
SM5	Y	N	N	N
SM6	Y	N	N	Y
SM7	N	N	N	Y
SM8	Y	Y	N	Y
SM9	Y	Y	N	Y
SM10	N	N	N	N
SM11	Y	Y	N	Y
SM12	Y	N	N	Y
SM13	Y	N	N	Y
SM14	Y	Y	Y	Y
SM15	Y	Y	N	Y
SM16	N	N	N	N
SM18	Y	N	N	Y
SM19	Y	Y	Y	Y
SM20	Y	Y	Y	Y
CH4	Y	Y	Y	Y
SM22	Y	Y	N	Y
SM23	Y	N	N	Y
SM24	Y	N	N	N
SM25	Y	N	N	Y
SM27	Y	Y	N	Y
SM28	Y	N	N	Y
SM29	N	Y	N	Y
SM30	Y	Y	N	Y
SM31	Y	N	N	Y
SM32	Y	Y	N	Y
SM34	Y	Y	Y	Y
No	13%	47%	80%	13%
Yes	87%	53%	20%	87%

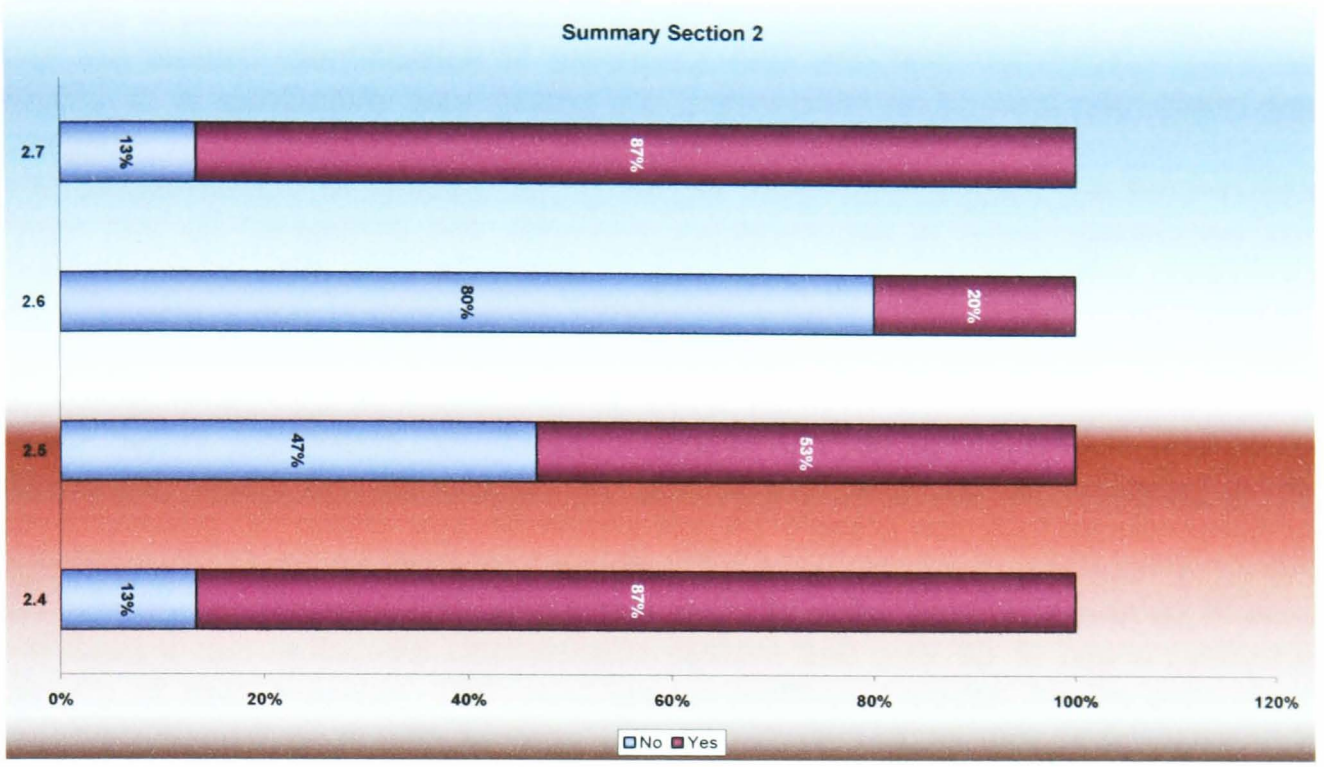


Table 6.28 Survey 1 Section 2 Summary

Section 3 Hazard Identification

Part 3.1 to 3.9

In the Survey 1 responders were also asked to define the structure and steps of risk management. Within operating companies participated almost every participant has some level of awareness in hazard identification beside the confusion between hazard and event. The level of involvement in implementing a hazard identification system varies considerably between companies with different type of ships. It seems that the highest the risk for undertaking liabilities the highest the level of implementing hazard identification system. On the other hand all companies have a system to report incidents, accidents, non conformities.

It is also of relevance that companies have set performance standards and accident/incident standards but hazard identification is not performed by using a structured technique but mainly based in non systematic methods like brainstorming and Pareto analysis.

There was quite a significant difference between answers given by participants to the awareness and implementation of hazard identification techniques. Almost all declared that had awareness or got information but limited study and implementation had previously taken place. The most well known techniques declared were what-if, human resource and check list analysis followed by Fault tree and event tree analysis. One explanation of poor implementation in hazard identification is that there is confusion between hazard and event. So the effort lies in the understanding and managing events instead of hazards for which of course hazard identification techniques are not applicable. Another possible explanation is the required capacity of the participant to investigate and identify the wide range of hazard's physical characteristics but in certain extend in order techniques to be feasible and applicable.

Books and publication seems to include limited information for hazard identification techniques and its applications. Very little information seems the

majority of participants received during last year. In many training courses seems that the hazard identification is presented and adequate information delivered mostly in a qualitative way giving the impression of hazard and event tree analysis.
The categorization of causes during hazard identification gives the fundamental issue that all categories are very-very important but in more specialized ship managers who were also advanced in structured hazard identification considered the following queue in importance categories priority:
1 - Unsafe conditions 37 %, 2-Unsafe act 33 %,
3- Human factors 22 %, 4-Working Factors 8 %.
Table below presenting results from section 3.1 up to 3.8 which analytically presented below for the companies participated and replies recorded in the questionnaire. Y means yes, N means No. A1 Unsafe act, A2 Unsafe condition, A3 Human Factors, A4 Working Factors.
Analytically in 3.1 parts defined that the majority of the participants in 67 % does not have a risk or hazard identification system and only 33 % has a system to identify all risks involved. This provides an additional reason for the area of my research since it dealt with an area with very limited systematic management. In part 3.2 defined that the majority of the participants in 83 % has a system to report all incidents and only 17 % has not yet systematically keeps a system for such important operation. This is very important since there is a foundation for recording data needed for further process and assessment. . In part 3.3 defined that the majority of the participants in 63 % has established performance standards for loss but a substantial part of 37 % has not yet systematically put standards for such important information. This is very important since by recording such performance a continuous improvement policy can be implemented and measurable aims can be placed to be followed by people onboard and ashore.
In part 3.4 defined that the majority of the participants in 73 % des not use structured techniques for hazard identification and only 27 % is using such techniques mainly from the types of high risk ships. From the techniques presented the highest awareness was for check list and brainstorming since is used in the implemented ISM system in an informal way. Human reliability, fault and even tree analysis following the techniques most commonly used in public information received within the ship related industry sources. This is also proved by part 3.5 in which the participants replied in a part of 60 % that they have received enough information from publications and only 40 % has not received for hazard identification techniques. Institutions providing training courses had not include risk management in their programme and only lately in end of 2004 there were such training courses that's why in part 3.6 the majority 57 % had not received such training information and the rest 43 % had received such information by other courses which include risk management elements such as environmental management systems, occupational health and safety in which no systematic and structured techniques presented. The important issue of hazards inventory seems that is missing from the shipping companies since in part 3.7 the majority of the participants in 67 % have not a cumulative list of hazards and only 33 % keep it in a quite basic form beside they are dealing in day to day operations which is the main reason for handling similar cases each time in a different way and many times repeating the same mistakes. This is also a

strengthen point for my research area since the basic elements for proper and systematic management set.

3.4	What If	Check List	HAZOP	FMEA	ETA	FTA	CCFA	HRA
SM2	1,2	1,2,3	N/A	N/A	1	1	N/A	1
SM4	1,2,3	1,2,3	N/A	N/A	1,2	1	N/A	1,2
SM14	1,2,3	1,2,3	1	1	1,2	1,2	1	1,2
SM19	1,2	1,2,3	N/A	N/A	1	1	N/A	1
SM20	1,2	1,2,3	1	N/A	N/A	N/A	N/A	1
SM30	1,2	1,2,3	1	1	1	1	1	1
SM32	1,2	1,2,3	1	1	1	1	1	1
SM34	1,2,3	1,2,3	1	1,2	1,2	1,2	1,2	1,2

Table 6.29 Survey 1 Section 3 Part 3.4 distribution

Section 3 Hazard Identification								
	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8
SM2	Y	Y	Y	Y	Y	Y	Y	A1/2,A2/1,A3/1,A4/3
SM3	N	N	Y	N	N	N	N	A1/1,A2/1,A3/2,A4/4
SM4	N	Y	Y	Y	Y	Y	Y	A1/1,A2/3,A3/2,A4/2
SM5	N	Y	N	N	Y	N	N	A1/1,A2/2,A3/3,A4/3
SM6	N	Y	N	N	N	N	N	A1/1,A2/1,A3/2,A4/4
SM7	N	N	N	N	N	N	N	A1/1,A2/2,A3/2,A4/3
SM8	N	Y	Y	N	Y	Y	Y	A1/2,A2/1,A3/4,A4/2
SM9	N	Y	Y	N	Y	Y	N	A1/1,A2/2,A3/3,A4/2
SM10	N	Y	N	N	N	N	N	A1/2,A2/2,A3/2,A4/3
SM11	N	Y	Y	N	Y	Y	Y	A1/1,A2/1,A3/2,A4/4
SM12	N	Y	Y	N	N	N	N	A1/1,A2/2,A3/3,A4/2
SM13	N	Y	N	N	Y	N	N	A1/2,A2/1,A3/2,A4/3
SM14	Y	Y	Y	Y	Y	Y	Y	A1/1,A2/2,A3/2,A4/2
SM15	N	Y	Y	N	Y	N	N	A1/1,A2/1,A3/4,A4/3
SM16	N	N	N	N	N	N	N	A1/2,A2/2,A3/2,A4/2
SM18	N	Y	N	N	Y	N	N	A1/1,A2/2,A3/1,A4/2
SM19	Y	Y	Y	Y	Y	Y	Y	A1/1,A2/1,A3/3,A4/3
SM20	Y	Y	Y	Y	Y	Y	Y	A1/1,A2/2,A3/2,A4/1
CH4	N	Y	Y	N	N	N	N	A1/1,A2/1,A3/2,A4/1
SM22	Y	Y	Y	N	Y	Y	N	A1/1,A2/2,A3/2,A4/2
SM23	N	Y	N	N	N	N	N	A1/1,A2/1,A3/1,A4/3
SM24	N	Y	Y	N	Y	N	N	A1/1,A2/2,A3/2,A4/3
SM25	N	Y	N	N	N	N	N	A1/1,A2/1,A3/3,A4/2
SM27	Y	Y	Y	N	Y	Y	N	A1/2,A2/2,A3/2,A4/3
SM28	Y	Y	N	N	N	N	N	A1/1,A2/1,A3/4,A4/3
SM29	N	N	N	N	N	N	N	A1/1,A2/2,A3/2,A4/3
SM30	Y	Y	Y	Y	Y	Y	Y	A1/1,A2/2,A3/3,A4/3
SM31	N	N	Y	N	N	N	N	A1/1,A2/2,A3/3,A4/3
SM32	Y	Y	Y	Y	Y	Y	Y	A1/1,A2/1,A3/3,A4/3
SM34	Y	Y	Y	Y	Y	Y	Y	A1/1,A2/3,A3/2,A4/3
Yes	33%	83%	63%	27%	60%	43%	33%	
No	67%	17%	37%	73%	40%	57%	67%	

Table 6.31 Survey1 Section 3 Part 3.1-3.2-3.3-3.4-3.5-3.6-3.7-3.8 Summary

3.5	What If	Check List	HAZOP	FMEA	ETA	FTA	CCFA	HRA
SM2	4	4	2	2	2	2	1	2
SM4	3	4	2	2	3	2	1	3
SM14	4	4	2	2	2	2	2	3
SM19	3	3	2	2	2	2	1	2
SM20	3	3	2	2	2	3	1	2
SM30	3	4	3	3	3	3	2	2
SM32	3	4	2	2	2	2	2	2
SM34	4	4	2	3	3	3	3	3

Table 6.30 Survey 1 Section 3 Part 3.5 distribution

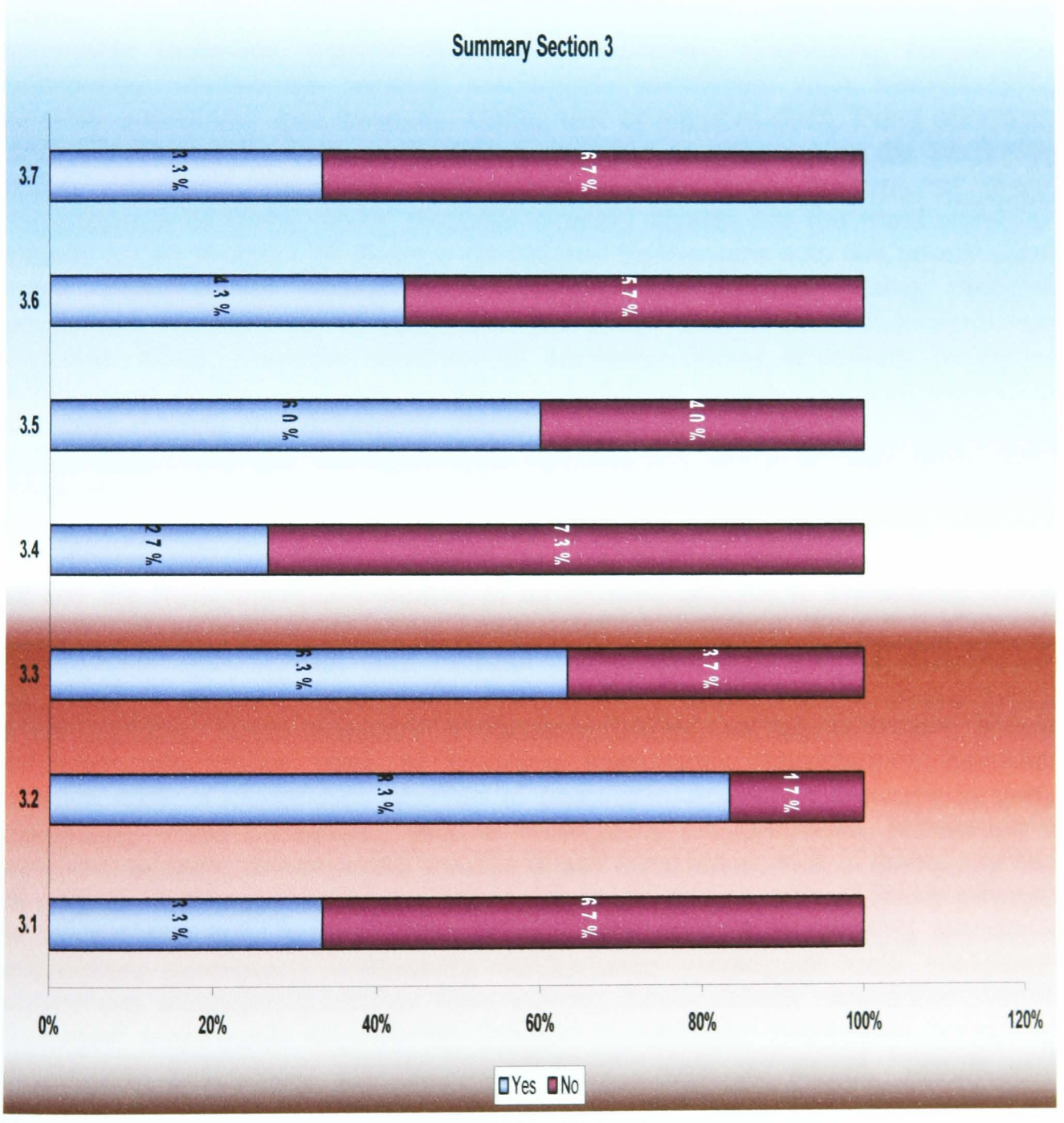


Table 6.32 Survey 1 Section 3 Part 3.1-3.2-3.3-3.4-3.5-3.6-3.7-3.8 Summary

In part 3.8 the participants tried to reply and evaluate the significance of each cause type creating often an incident in day to day operations. The understanding of each category was basically difficult and a more detailed list was needed in order to clarify the boundaries of each category. For that reason I have provided with a list which describes in details the causes pertinent to each category. This list expedites the decision of the participants regarding significance of each category. The list was presented in pages 45 and 46 in Chapter 2 for easy reference. The participants in apart of 37 % declared that unsafe conditions such as inadequate safeguards, inadequate or improper Personal Protective Equipment, defective tools, defective materials, incorrect loading, workspace restrictions, hazardous conditions, fires, dropped objects, flammable materials, engine overloading, corrosion weakening, temperature differences, inadequate lighting, inadequate ventilation, poor housekeeping, weather conditions, gas releases, traffic, wet or slippery deck, living conditions ,ship conditions(trim ect), uncharted submerged pieces, design life exceeded, noise, unreliable Charterer, inadequate escape route, berths not ready, overpressure of tanks, waste disposal, floating objects are the most significant causes for an incident 33 % were considered that unsafe acts like unauthorized entry, unauthorized operation, removing safety devices, using defective equipment, improper use of equipment, not using Personal Protective Equipment, improper lifting, improper contracting, servicing during operation, horseplay, influence of alcohol or drugs, entering in enclosed space, improper monitoring, improper loading or discharging, improper positioning, improper route planning, traffic rules violation, deviation from course, hot works in gas area, spark generation, lack of maintenance, improper supervision, improper handling, improper operation, making barriers inoperable, improper heating, improper connection, improper filling, improper care, improper repairs, release of sludge or oil are the most significant causes of an incident and 22 % considered human factors such as trained personnel, communication problems, inhalation of harmful substances, skin contact with harmful substances, eye contact with harmful substances, mentally inadequate, lack of knowledge, lack of skills, lack of understanding, stress, improper motivation, fatigue, vertigo, oversight, lack of following procedures, lack of following instructions, complacent, untrained officers, lack of leadership, warning of personnel, economic pressure to hurry, neglecting traffic conditions, lack of emergency preparedness, knowledge of inherent dangers, overreacting, excess of self confidence, lack of timely payment of wages, family problems, invalidism, low scale wages, lack of timely payment of wages and only 8 % working factors such as lack of working standards, inadequate purchasing, inadequate maintenance, inadequate tools, inadequate equipment, engineering failures, team training, heavy objects, unsecured objects, leakages, inadequate engineering, equipment reliability, inadequate leadership, inadequate supervision, communication failure, improper stores, unsafe work practice, schedule of maintenance, lack of working orders, improper valve operation, not original spares, defective sounding pipes, beaten tools, worn out equipment, worn out hoses, rotten tools, start operation failure, old falls or gripes, proper neutral gas, lack of awareness and non routine start operation failure.

3.8	1	2	3	4
A1	24	6	0	0
A2	13	15	2	0
A3	3	16	8	3
A4	2	9	16	3
Total	43	48	29	10
PCT	33%	37%	22%	8%

Type	Unsafe Act	Unsafe Conditions	Human Factors	Working Factors
Total	43	48	29	10
PCT	33%	37%	22%	8%

Table 6.33 Survey 1 Section 3 Part 3.8 distribution

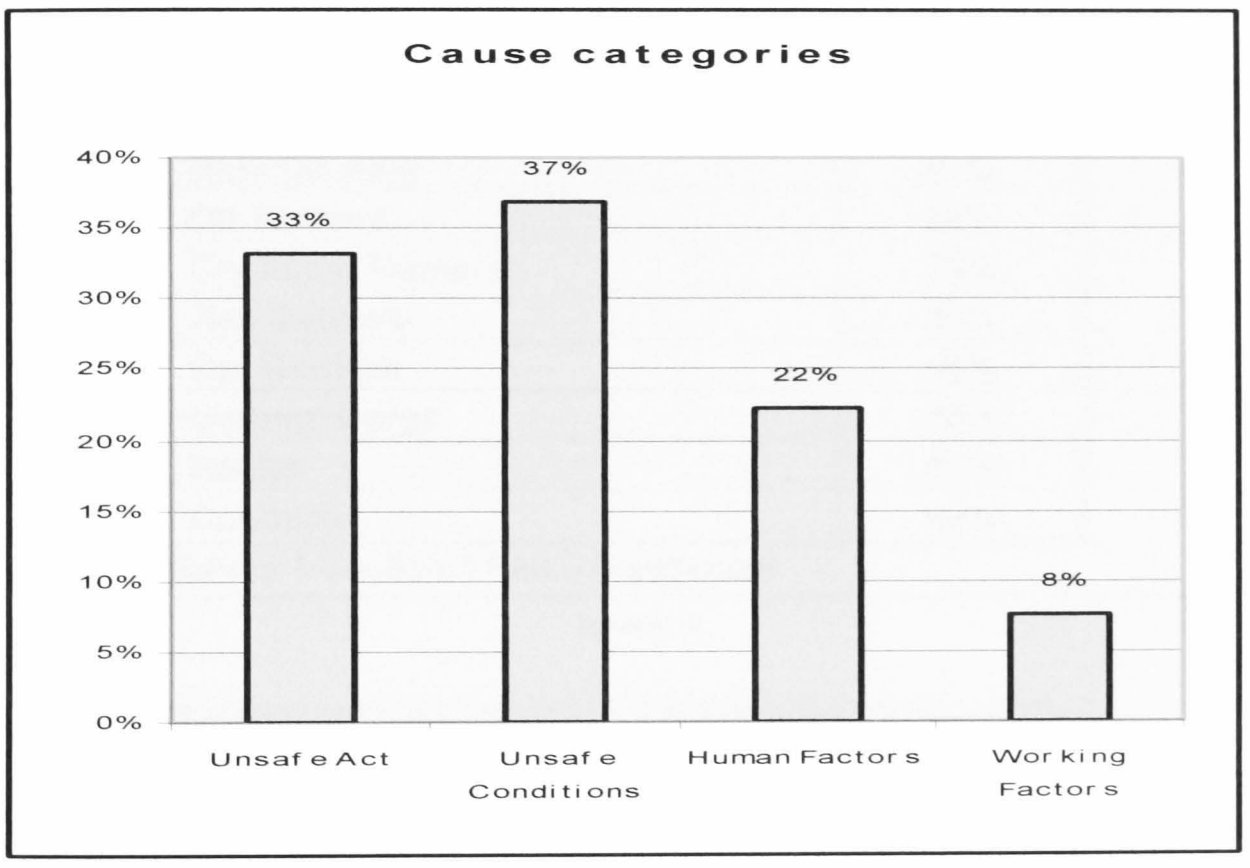


Table 6.34 Survey 1 Section 3 Part 3.8

In part 3.9 the participants were asked to identify activities with associated hazards which were relative to their experience and fleet type within their duties. Participants had the choice to select from a group of 8 ships' type and to follow certain list with check boxes. Results received presented in the following tables with relative comments. It should be noted that same group were used in determination and fulfillment of case studies during Survey 2 presented in the Appendices as Tables 3.9.XX. In this part a list of shipping and shipboard activities were identified in various areas of ship management. This list of activities parts of totally 24 activity categories in which 280 activity items are included. From the results received by the responders the participation in questionnaires made relatively to the ship's types and the replies were analyzed for activities with identifiable risks of associated hazards. The participants presented in the following table.

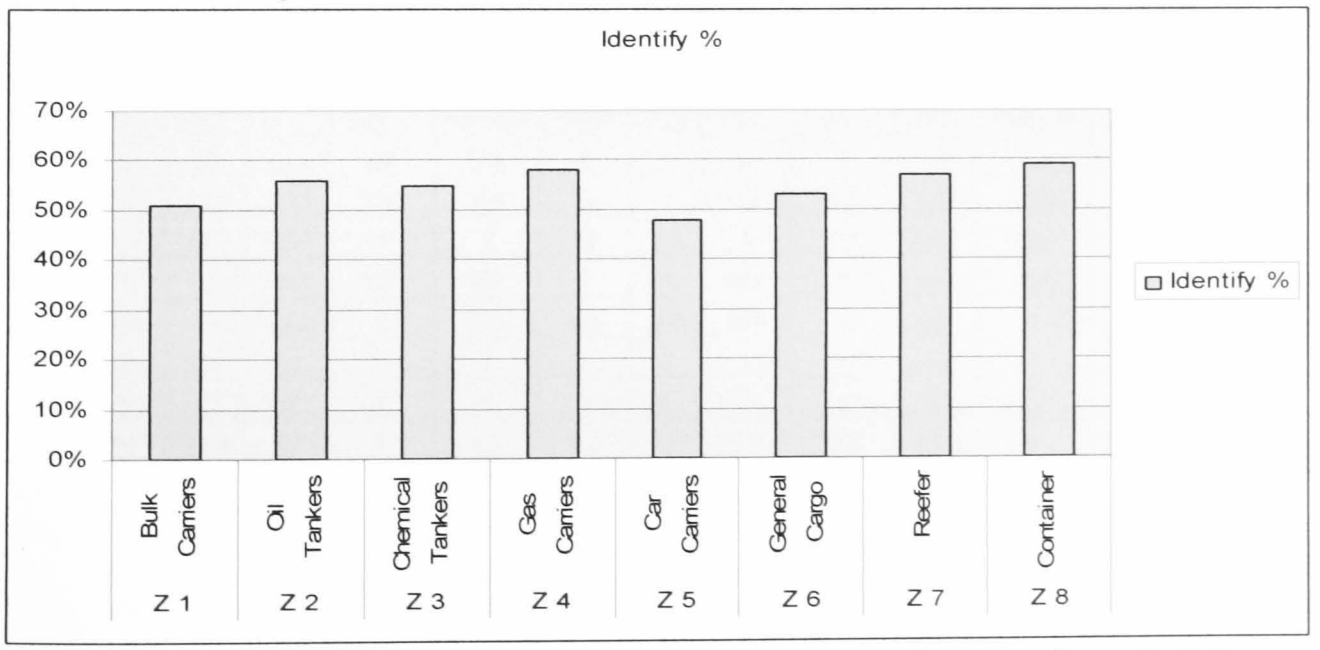
Z 1	Bulk Carriers	20
Z 2	Oil Tankers	12
Z 3	Chemical Tankers	3
Z 4	Gas Carriers	4
Z 5	Car Carriers	4
Z 6	General Cargo	5
Z 7	Reefer	6
Z 8	Container	5

Table 6.35 Survey 1 Section 3 Part 3.9 responder's distribution

The responder's replied for the activities they were aware of risks emanated from associated hazards by an average which presented below.

No	Type	Identify %
Z 1	Bulk Carriers	51%
Z 2	Oil Tankers	56%
Z 3	Chemical Tankers	55%
Z 4	Gas Carriers	58%
Z 5	Car Carriers	48%
Z 6	General Cargo	53%
Z 7	Reefer	57%
Z 8	Container	59%

Table 6.36 Survey 1 Section 3 Part 3.9 summary



In the subcategories described in the survey there have been gathered all three stages in different activities which are indicative for the conditions defined above. This part was designed to gather descriptive data on the responders to see if there is any particular involvement in hazard identification, analysis and implementation of identification techniques. Responder's data received across categories and subcategories gave a view that the vast majority can identify and analyze hazards without to implement specific techniques other than causation

chain and effect consequences analysis by which the level of management considered adequate for the first stage.
Additional categories and subcategories proposed during the survey which was under consideration and some have been included in the final list of activities and as an example the Dry-docking activity was one which was included in the list at a later stage.

Section 4 Risk Analysis

Part 4.1 to 4.8

In Survey 1 and within the steps of risk management, risk analysis is the second step for estimation of risk on as is basis. Ship Management companies participated responders gave a significant portion of positive reply of about 70 % percent for implementing a risk analysis system with which they evaluated significance and criticality of shipping activities. The level of involvement in implementing a Risk analysis system's methods varies considerably between companies with different type of ships followed by the same concept of the highest the risk for undertaking liabilities the highest the level of implementing risk analysis system.
There was also here similarly a significant difference between answers given by participants to the awareness and implementation of risk analysis methods. More than half declared that had awareness or got information but limited study and implementation had previously taken place. In part 4.2 defined that the majority of the participants in 53 % are aware and use structured methods for risk analysis but also 47 % is not using such methods mainly from the types of low risk ships. From the methods presented the highest awareness was for check list, What If and preliminary hazard and risk analysis since is used in the implemented ISM system in an informal way. Human reliability, change analysis, fault and even tree analysis following the methods most commonly used within participants in the ship related industry.

4.2	PHA	PRA	What If	CHECK LIST	HAZOP	FMEA	ETA	FTA	CCFA	HRA	PARETO	CHANGE	CRA	RR
1,2	1	1,2	1,2,3	N/A	N/A	1	1	N/A	1	1,2	1,2	1	1	
1,2,3	1,2	1,2,3	1,2,3	N/A	N/A	1,2	1	N/A	1,2	1,2,3	1,2,3	N/A	N/A	
1,2,3	1,2	1,2,3	1,2,3	1	1	1,2	1,2	1	1,2	1,2,3	1,2,3	1	1	
1,2	1	1,2	1,2,3	N/A	N/A	1	1	N/A	1	1,2	1,2	N/A	N/A	
1,2	N/A	1,2	1,2,3	1	N/A	N/A	N/A	N/A	1	1,2	1	1	1	
1,2	1	1,2	1,2	1	1	1	1	1	1	1,2	1	1	1	
1,2	1	1,2	1,2,3	1	1	1	1	1	1	1,2	1,2	1	1	
1,2,3	1,2	1,2,3	1,2	1	1,2	1,2	1,2	1,2	1,2	1,2,3	1	1	1	
1,2,3	1,2	1,2,3	1,2	1	1	1,2	1,2	1	1,2	1,2	N/A	N/A	N/A	
1,2	1	1,2	1,2,3	N/A	N/A	1	1	N/A	1	1	1	1	1	
1,2	N/A	1,2	1,2	1	N/A	N/A	N/A	N/A	1	1	1	1	1	
1,2	N/A	1,2	1,2,3	1	N/A	N/A	N/A	N/A	1	1,2	1,2	1,2	1,2	
1,2	1	1,2	1,2	1	1	1	1	1	1	1	1,2	1,2	1,2	
1,2	1	1,2	1,2,3	1	1	1	1	1	1	N/A	1,2	1,2	1,2	
1,2,3	1,2	1,2,3	1,2	1	1,2	1,2	1,2	1,2	1,2	1	1,2,3	1,2	1	
1,2,3	1,2	1,2,3	1,2	1	1	1,2	1,2	1	1,2	1	1,2	1,2	1	
1,2	1	1,2	1,2,3	N/A	N/A	1	1	N/A	1	1,2	1,2	1	1,2	

Table 6.37 Survey 1 Section 4Part 4.2 summary

For books and publication pertinent to risk analysis methods it seemed that enough information is included for risk analysis methods and its applications. This is defined in part 4.3 in which the participants replied in a part of 53 % that they have received enough information from publications mainly for methods used above and 47 % has not identified information for risk analysis methods. From those received information from publications the below risk analysis methods supposed to be presented with 4 for a lot of information to 1 with almost not information at all.

4.3	PHA	PRA	What If	CHK LIST	HAZ OP	FME A	ETA	FTA	CCF A	HRA	PAR ETO	CHA NGE	CRA	RR
SM2	2	2	4	2	2	2	2	3	4	3	4	3	4	N/A
SM4	3	3	4	2	2	3	2	3	3	3	4	3	3	N/A
SM8	3	3	4	2	2	2	4	2	4	2	4	2	4	1
SM9	2	2	3	2	2	2	2	3	3	3	3	3	3	N/A
SM11	2	2	3	2	2	2	3	2	3	2	3	2	4	2
SM12	2	2	4	3	3	3	3	2	3	2	4	2	3	1
SM14	2	2	4	2	2	2	2	2	3	2	4	2	3	2
SM15	3	3	4	2	3	3	3	3	4	3	4	3	4	2
SM19	3	3	4	2	2	3	2	2	3	2	4	2	3	N/A
SM20	3	3	4	2	2	2	2	2	4	2	4	2	4	1
SM22	2	2	3	2	2	2	4	4	3	4	3	4	3	N/A
SM24	3	3	4	2	2	3	4	3	3	3	4	3	3	N/A
SM27	3	3	4	2	2	2	2	2	4	2	4	2	4	2
SM30	2	2	3	2	2	2	3	2	3	2	3	2	3	N/A
SM32	2	2	4	2	2	2	2	2	3	2	4	2	3	1
SM34	3	3	4	2	3	3	3	3	4	3	4	3	4	1

Table 6.38 Survey 1 Section 4Part 4.3 summary

As previously mentioned institutions providing training courses had not include risk management and specifically risk analysis methods in their programme that's why very little information seems the majority of participants received during last year so in part 4.4 the majority of 60% had not received such training information and the rest 40 % had received such information by other courses which include risk management elements such as environmental management systems, occupational health and safety in which no systematic in which some methods were presented.

In part 4.5 the responders replied that risk analysis methods presented are mostly used in as qualitative methods by the use of risk matrices. Risk analysis methods were well known to the participants and qualitative was concluded by the majority as the most important and reasonably practical. Some participants defined also quantitative as the most useful method subject existence of relative historical data which however is very limited for a wide variety of shipping activities and hazards. In part 4.5 the 90% declared that qualitative is the most important, semi quantitative considered important by 55% of the participants and quantitative considered important by 40% of the participants.

4.5	Method	Important	Not important
A1	Qualitative	90%	10%
A2	Semi Quantitative	55%	45%
A3	Quantitative	40%	60%

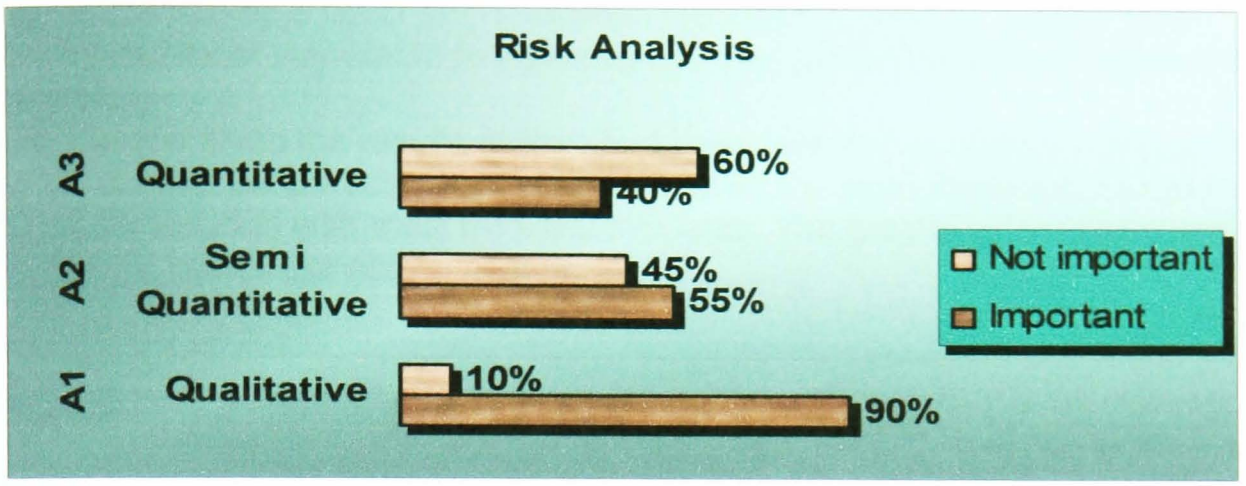


Table 6.39 Survey 1 Section 4Part 4.5 summary

The participants identified easily the importance of impact categories and relation to the liabilities emanated by the failures during risk analysis within their company's activities. In Part 4.6 all considered very-very important the impact to people either general public or the crew, by 55% to air pollution since ships are limited units trading in a wide geographical area and only specific trading area could have an impact, by 65 % to marine life since precautions now for garbage, sludge and ballast implied, 35% to ozone depletion since now Freon 22 and other substances are not any more used in shipping, 17% to resource depletion since limited resources used by ships other than fuel with substantial reduction of consumption in new designs, 28% to land contamination, 20% to acid rain emanated mainly from the pollution of the air by fuel combustion and 80% priority has given to the impact of property damages either in ship or to port facilities since there are certain liabilities related with that as well as to sequential damages to human and environment. This gives the conclusion that maritime companies are well aware of the impacts emanated from their activities and is focused to control, limit or reduce such impacts by shipping activities.

IMPACT	A1	A2	A3	A4	A5	A6	A7	A8
Importance	100%	55%	65%	35%	17%	28%	20%	80%

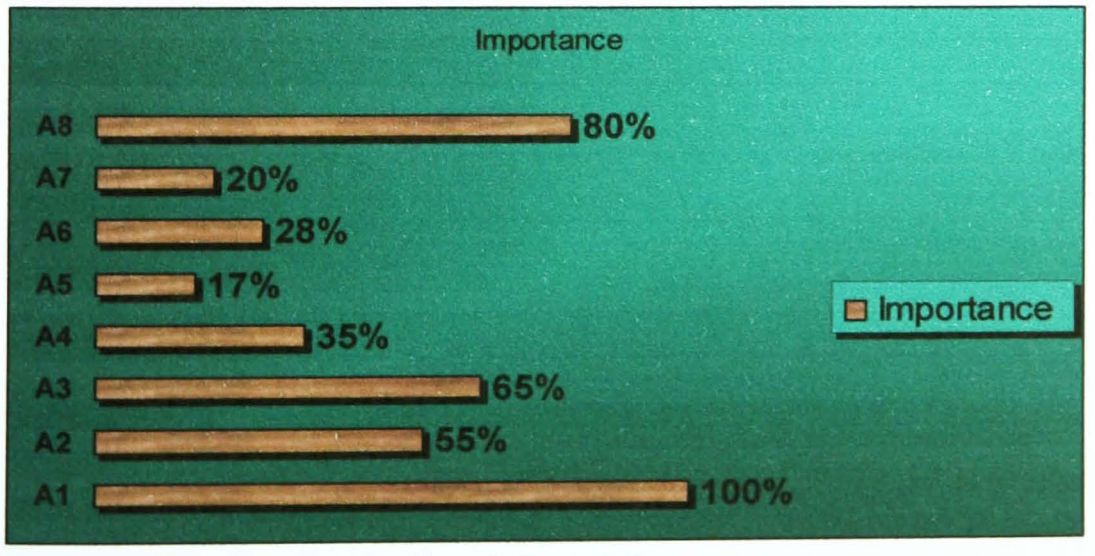
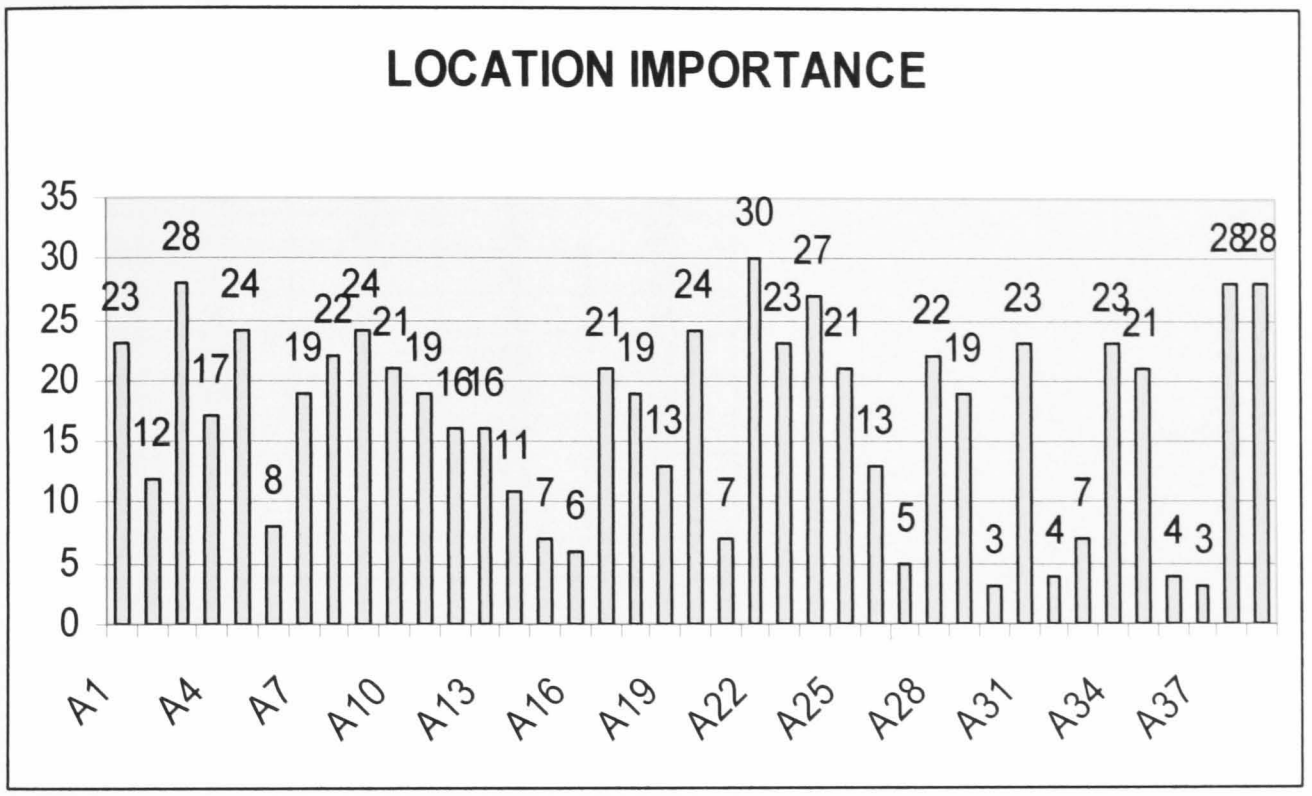
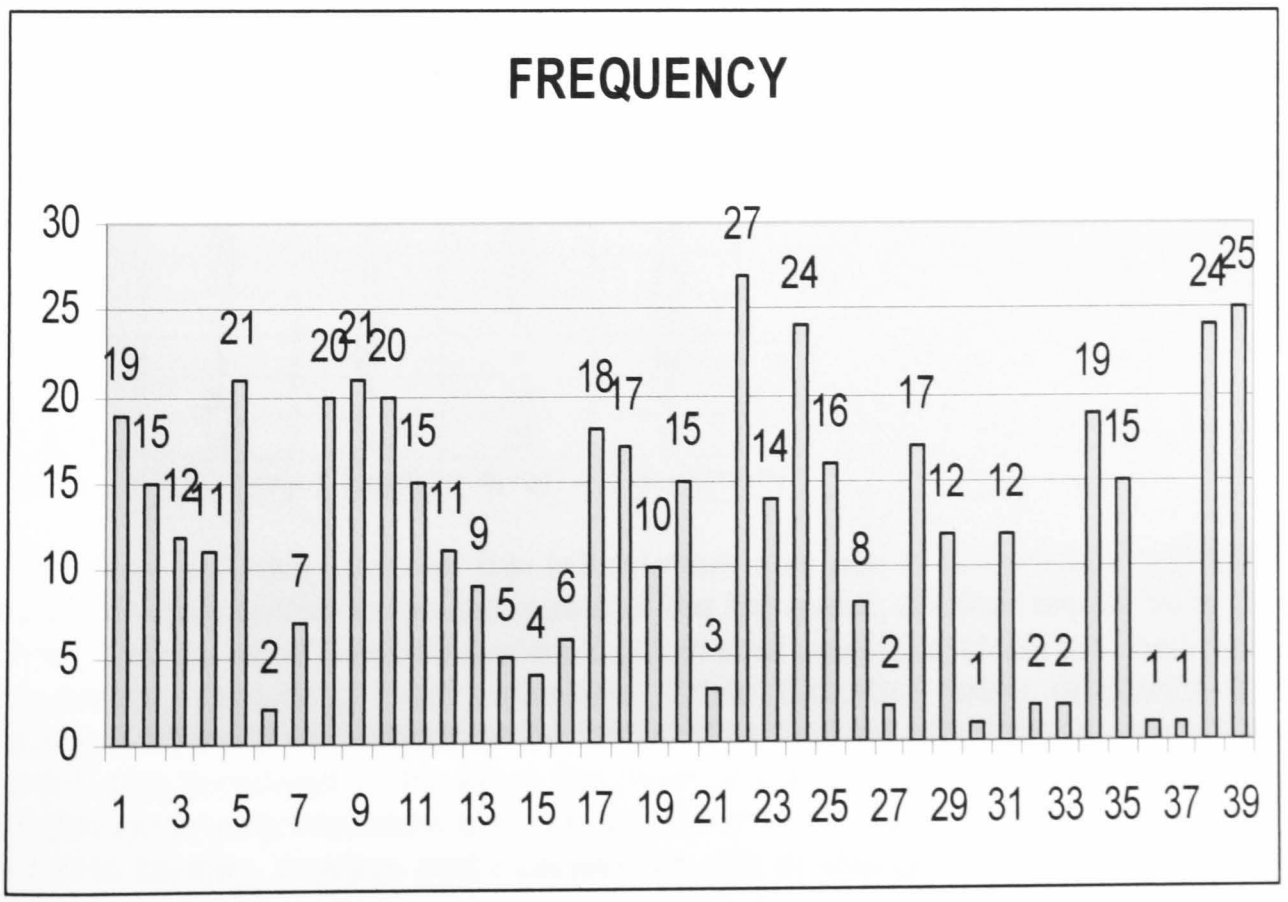


Table 6.40 Survey 1 Section 4 Part 4.6 summary

During the survey a list of ship's location identified in order to assess which areas considered most vulnerable to incidents and the assessment of importance and frequency.
Table below gives the results of the most important and frequent locations. The Table collects the participant's opinion by L2 as the most important location and F2 as the location with most frequent incidents. The graphs below represent the L2 and F2 values per ship's location.





4.7	L2	L1	F2	F1
A1	23	7	19	11
A2	12	18	15	15
A3	28	2	12	18
A4	17	13	11	19
A5	24	6	21	9
A6	8	22	2	28
A7	19	11	7	23
A8	22	8	20	10
A9	24	6	21	9
A10	21	9	20	10
A11	19	11	15	15
A12	16	14	11	19
A13	16	14	9	21
A14	11	19	5	25
A15	7	23	4	26
A16	6	24	6	24
A17	21	9	18	12
A18	19	11	17	13
A19	13	17	10	20
A20	24	6	15	15
A21	7	23	3	27
A22	30	0	27	3
A23	23	7	14	16
A24	27	3	24	6
A25	21	9	16	14
A26	13	17	8	22
A27	5	25	2	28
A28	22	8	17	13
A29	19	11	12	18
A30	3	27	1	29
A31	23	7	12	18
A32	4	26	2	28
A33	7	23	2	28
A34	23	7	19	11
A35	21	9	15	15
A36	4	26	1	29
A37	3	27	1	29
A38	28	2	24	6
A39	28	2	25	5

Table 6.41 Survey 1 Section 4Part 4.7 summary

There two possible uses for this information: one use is to correlate with activity to assign distribution to the estimates of the top event; another would be to check if there is any relationship between location and causation chain and their level of correlation regarding their estimates. Other locations were proposed during survey and were considered to be included to final list of locations, one example which was proposed in the list is the must house and windlass area. The impact of change is very important and was identified by all participants in the survey. An effort to identify, analyze and evaluate the risk of change is clearly defined in the

replies of participants irrelatively the qualitative characteristics of the identification system for the potential consequences.
During the survey a list of incident types were identified in Part 4.8 in order to categorize which incidents considered most important and frequent.
Table below gives the results of the most important and frequent incident types.

4.8	L2	L1	F2	F1
A1	30	0	5	15
A2	22	8	17	13
A3	23	7	18	12
A4	21	9	9	21
A5	22	8	19	13
A6	27	3	17	13
A7	29	1	19	11
A8	26	4	22	8
A9	5	25	2	28
A10	18	12	13	17
A11	4	26	2	28
A12	14	16	9	21
A13	22	8	15	15
A14	27	3	25	5
A15	5	25	9	21
A16	12	18	10	20
A17	9	21	5	25
A18	13	17	16	14
A19	29	1	9	21
A20	23	7	5	25
A21	26	4	10	20
A22	23	7	9	21
A23	17	13	15	15
A24	12	18	14	16
A25	20	10	14	16
A26	19	11	7	23
A27	11	19	10	20
A28	22	8	12	18
A29	21	9	10	20
A30	22	8	15	15
A31	12	18	5	25
A32	30	0	12	18
A33	17	13	16	14
A34	27	3	7	23
A35	18	12	15	15
A36	14	16	12	18

Table 6.43 Survey 1 Section 4 Part 4.8 summary

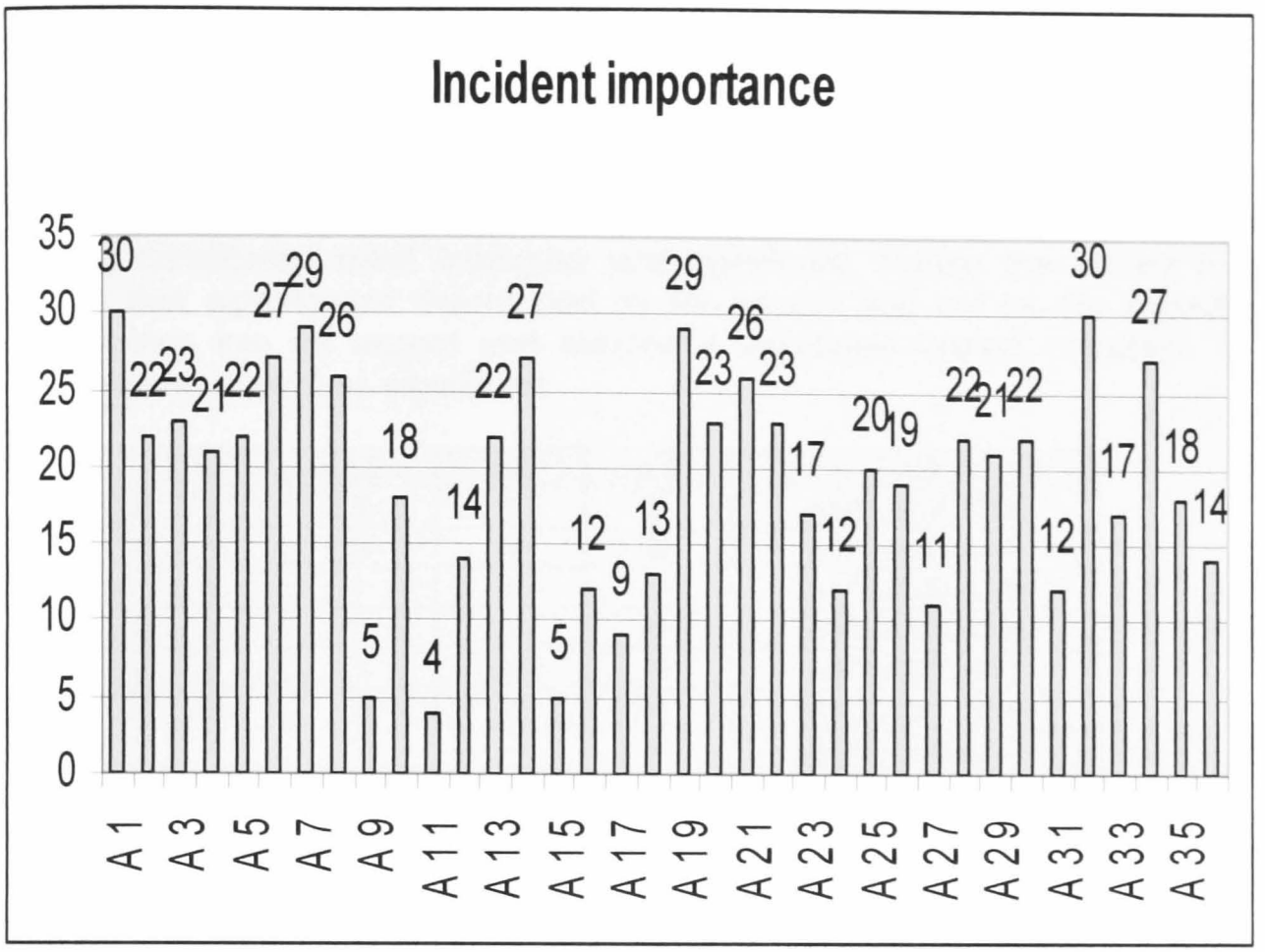


Table 6.42 Survey 1 Section 4 Part 4.8 incident importance

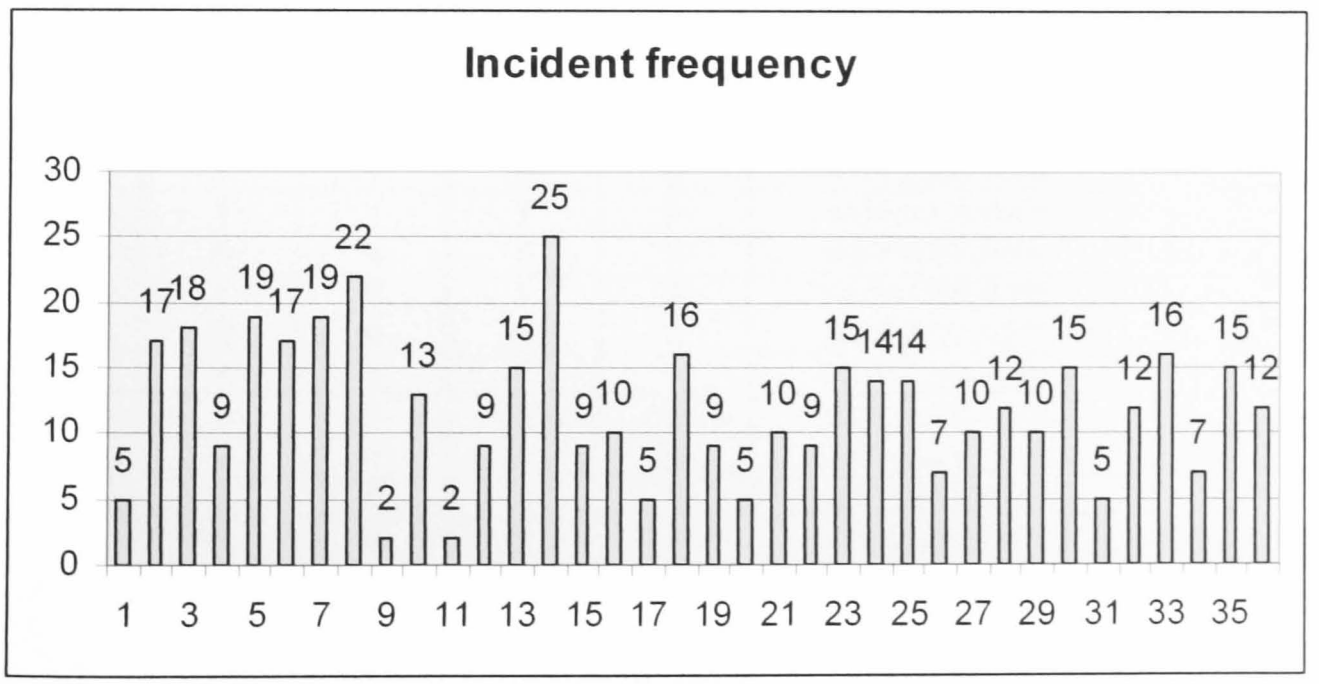


Table 6.44 Survey 1 Section 4 Part 4.8 incident frequency

There two possible uses for this information: one use is to correlate with top event to assign distribution to the estimates of the consequences; another would be to check the relationship between incident and causation chain and their level of correlation regarding their estimates. This will fall into four categories of direct and indirect cause (unsafe act-unsafe condition-job factors-human factors)

described above. Types of incidents had confused the participants since are strongly related to the activities but actually describing the top event and its categories. Other incidents were proposed during survey and were considered to be included to final list of incidents; one example which was proposed in the list is the Harmful environment and Stowaways.
During the survey a list of aspects were identified in order to categorize which aspects considered most important and significant. During the survey it was cleared that significance determined by the impact and not by the aspect. An event which has an aspect and creates a significant impact considers in its management aspect as significant.

	4.1	4.2	4.3	4.4	4.5
SM2	Y	Y	Y	Y	A1/Y,A2/N,A3/N
SM3	N	N	N	N	A1/Y,A2/N,A3/N
SM4	Y	Y	Y	Y	A1/Y,A2/N,A3/N
SM5	Y	N	N	N	A1/Y,A2/N,A3/N
SM6	Y	Y	N	N	A1/Y,A2/Y,A3/Y
SM7	N	N	N	N	A1/Y,A2/Y,A3/N
SM8	Y	Y	Y	Y	A1/Y,A2/N,A3/Y
SM9	Y	Y	Y	Y	A1/Y,A2/Y,A3/Y
SM10	N	N	N	N	A1/Y,A2/Y,A3/N
SM11	Y	Y	Y	Y	A1/Y,A2/N,A3/N
SM12	Y	N	Y	N	A1/Y,A2/Y,A3/Y
SM13	N	N	N	N	A1/Y,A2/N,A3/N
SM14	Y	Y	Y	Y	A1/Y,A2/N,A3/N
SM15	Y	Y	Y	N	A1/Y,A2/Y,A3/Y
SM16	N	N	N	N	A1/Y,A2/Y,A3/N
SM18	Y	N	N	N	A1/Y,A2/N,A3/Y
SM19	Y	Y	Y	Y	A1/Y,A2/Y,A3/Y
SM20	Y	Y	Y	Y	A1/N,A2/Y,A3/N
CH4	Y	Y	N	N	A1/Y,A2/N,A3/N
SM22	Y	Y	Y	Y	A1/Y,A2/N,A3/Y
SM23	N	N	N	N	A1/Y,A2/Y,A3/N
SM24	Y	N	Y	N	A1/N,A2/N,A3/N
SM25	N	N	N	N	A1/Y,A2/Y,A3/Y
SM27	Y	Y	Y	Y	A1/Y,A2/Y,A3/N
SM28	Y	Y	N	N	A1/Y,A2/N,A3/N
SM29	N	N	N	N	A1/Y,A2/Y,A3/Y
SM30	Y	Y	Y	Y	A1/Y,A2/Y,A3/N
SM31	N	N	N	N	A1/N,A2/N,A3/Y
SM32	Y	Y	Y	Y	A1/Y,A2/Y,A3/Y
SM34	Y	Y	Y	N	A1/Y,A2/N,A3/N
Yes	70%	53%	53%	40%	A1/90%,A2/55%,A3/40%
No	30%	47%	47%	60%	A1/10%,A2/45%,A3/60%

Table 6.45 Survey 1 Section 4 Part 4.1-4.5

Section 5 Risk Assessment
Part 5.1 to 5.16

In Survey 1 and within the steps of risk management, risk assessment is the third step for evaluation of risk as to acceptability. Participants in the survey have given the sense of awareness for the Formal Safety Assessment FSA, a method which has been proposed by IMO with relative guidelines as a structured method for risk assessment. That's why the replies in this question was mixed by those who understood and were informed about FSA and replied positive (Yes) and by those who were not aware and replied (no). There is a ground for confusion in that point and was clarified during the survey. The FSA is a rational and systematic process derived in 5 steps which are –

1. Hazard identification
2. Risk Analysis
3. Risk Control Options
4. Cost benefit assessment
5. Recommendation for decision Making

On the other hand risk assessment by its

- Qualitative
- Semi quantitative
- Quantitative,

form defines whether or not an activity should be permitted and whether measures needed to reduce risks. Participants replied considerably positive for the determination of risk acceptance criteria emanated from their experience and limitation of liabilities within insurance and Protection and Indemnity covers. The ALARP principle beside the prescriptive concept has not been formally introduced in operations since criteria are not always easily to establish. From the replies seems that ALARP principle is not used by the companies to reduce level of risk as low as reasonably practicable. Analytically in 5.1 parts defined that the majority of the participants in 57 % have a formal risk assessment programme and 43 % has not a system to identify all risks involved. This provides an additional reason for the area of my research since it dealt with an area which requires systematic risk management by quality, safety, environmental and lately occupational health standards.

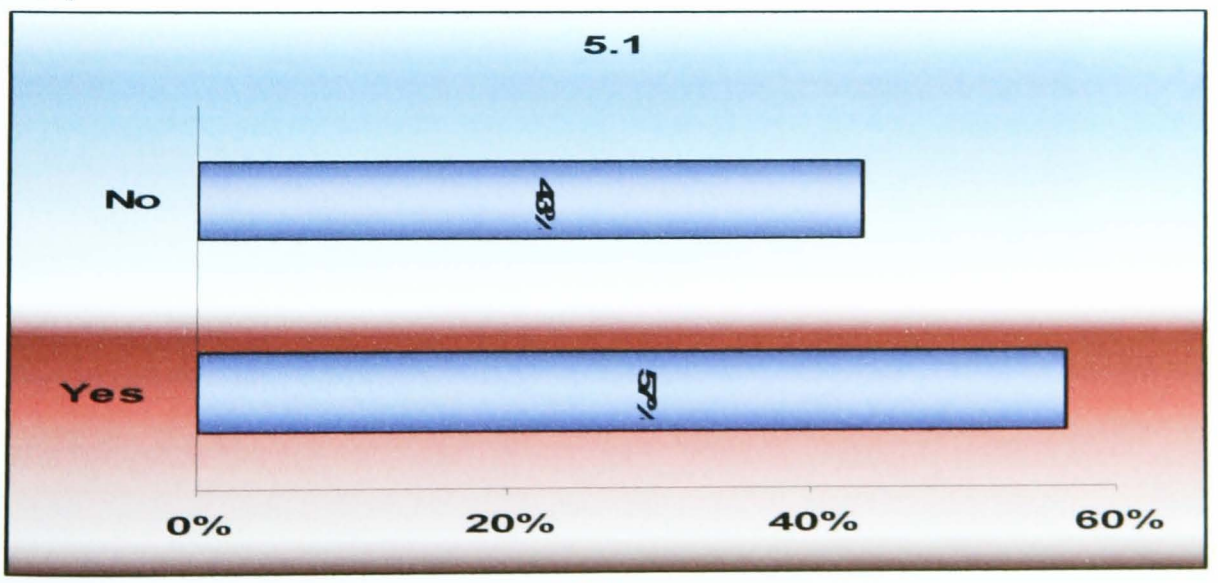


Table 6.46 Survey 1 Section 5 Part 5.1

In part 5.2 defined that the majority of the participants in 53 % has set risk acceptance criteria to determine risk acceptable level and 47 % has not yet set criteria for such important operation. This is very important since the decision making process needed cleared and defined criteria to evaluate whether or not a hazard should be treated by additional control measures.
In Part 5.3 the responders replied that there is no any list of control options by a part of 73% and only 27% replied that they keep a list of available control options. The level of involvement in implementing a Risk assessment is high and more over almost all declare that they are interest to embody risk assessment in their day to day operation.

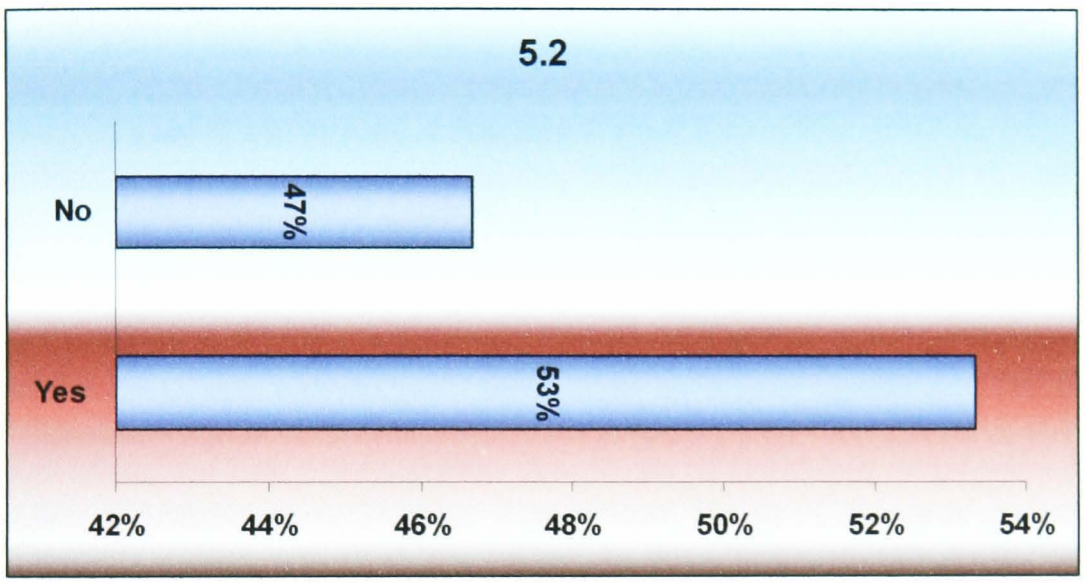


Table 6.47 Survey 1 Section 5 Part 5.2

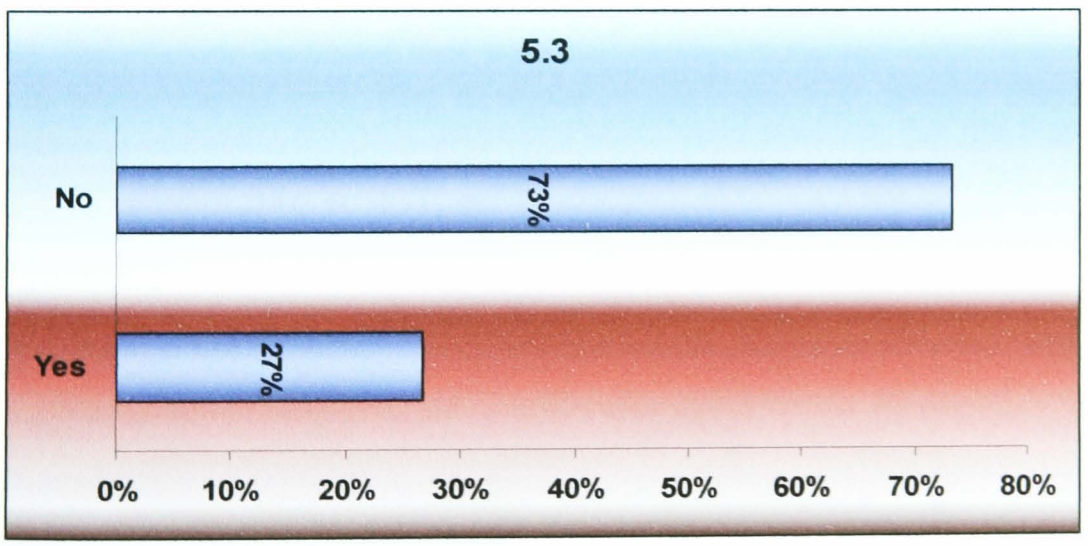


Table 6.48 Survey 1 Section 5 Part 5.3

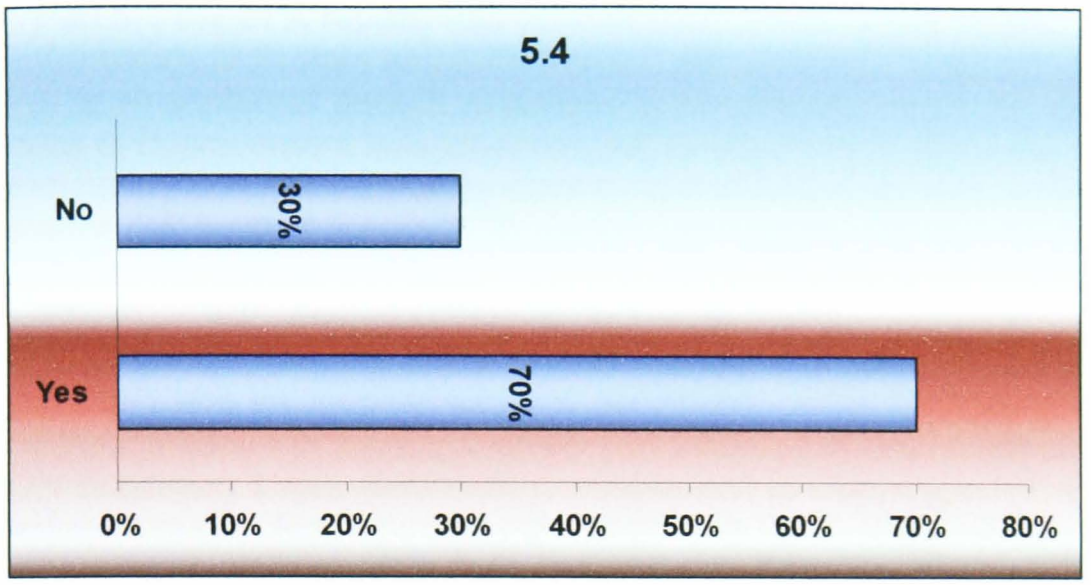


Table 6.49 Survey 1 Section 5 Part 5.4

In Part 5.4 defined that the majority of the participants in 70 % consider that risk assessment should be embodied in day to day operations and only 30% has not yet consider implementing risk assessment for shipping operations. There was also a positive reaction by almost all participants to the existence of a system for response of the impacts of unplanned occurrences. In Part 5.5 for the qualitative approach of risk assessment there was a general consent to the scale of Frequency index and Severity index proposed by IMO and IACS in the FSA guidelines for risk assessment. The scale of likelihood or frequency and severity index is presented in Chapter 3 pages 98, 99 as FI (Frequency index, SI (Severity index) and RI (Risk index). In the proposed indices for severity it is not included ranking for the environmental effects and reputation. By applying similar conceptual framework for which all participants agreed a logarithmic index for severity of all 4 effects categories created and presented in Table of page 99.Participants declared that their companies have not yet officially established key performance indicators to measure management system effectiveness in meeting company's goals and regulatory requirements but the majority declared that this is something under preparation in view of implementation of TMSA(Tanker Management and Self Assessment) best practice guide recently introduced.

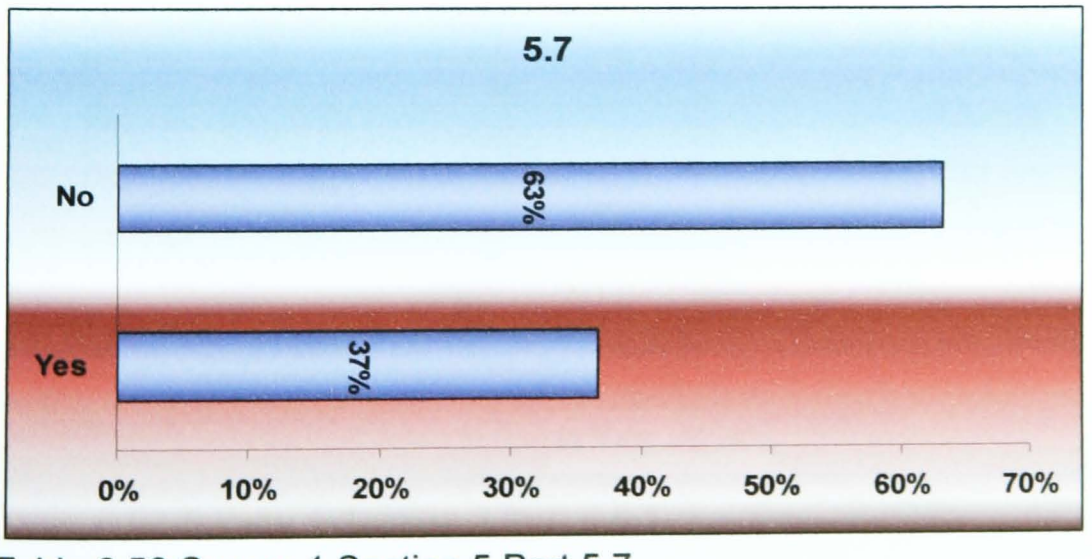


Table 6.50 Survey 1 Section 5 Part 5.7

In Part 5.7 the 37% replied that participant's company has established performance indicators and 63% has not yet consider t establish such indicators. This is an additional benefit emanated by my research since by determining areas of improvement indicators can easily implied and achieved. In Part 5.8 responders considered that by combination of frequency and severity index a relative risk created for which all participants agreed that due to the lack of guidance for actions and time scale the one presented is preferable in combination with second choice of IMO SUM SI+FI.
A major benefit from my research and surveys as it has been presented also previously was the involvement and awareness of risk management system for the participants. For Survey 1 which was a survey of awareness since from the very beginning it was obvious that a major part in shipping industry had not clear and systematic idea regarding risk adoption in the management system. There were a lot of participants in first contact for participation that had the idea that risk management was a financial framework related to the finance of widely and maybe reasonably considered high risk business of shipping. So it was of a great help this survey of awareness acting as a gap analysis for risk related issues. Qualitative risk assessment considered by participants fairly easy to apply and almost all questions were replied positively apart of adding costs for improving controls proactively. In Part 5.9 the replies provide support to the objectives emanated by the research project. In question 1 a part of 83% considered that risk assessment is easy to apply and requires no special skill to be implemented by the operation team. In question 2 the majority 90% agreed that risks are treated consistently.
In question 3 the majority of 87% agreed that hazards prioritized for reduction. In question 4 the majority of 63% considered that it should not determine the most pessimistic scenario and outcome. In Question No 5 the 47% of participants have not clear consideration whether or not expenses increased by implementing risk assessment and putting additional control measures.

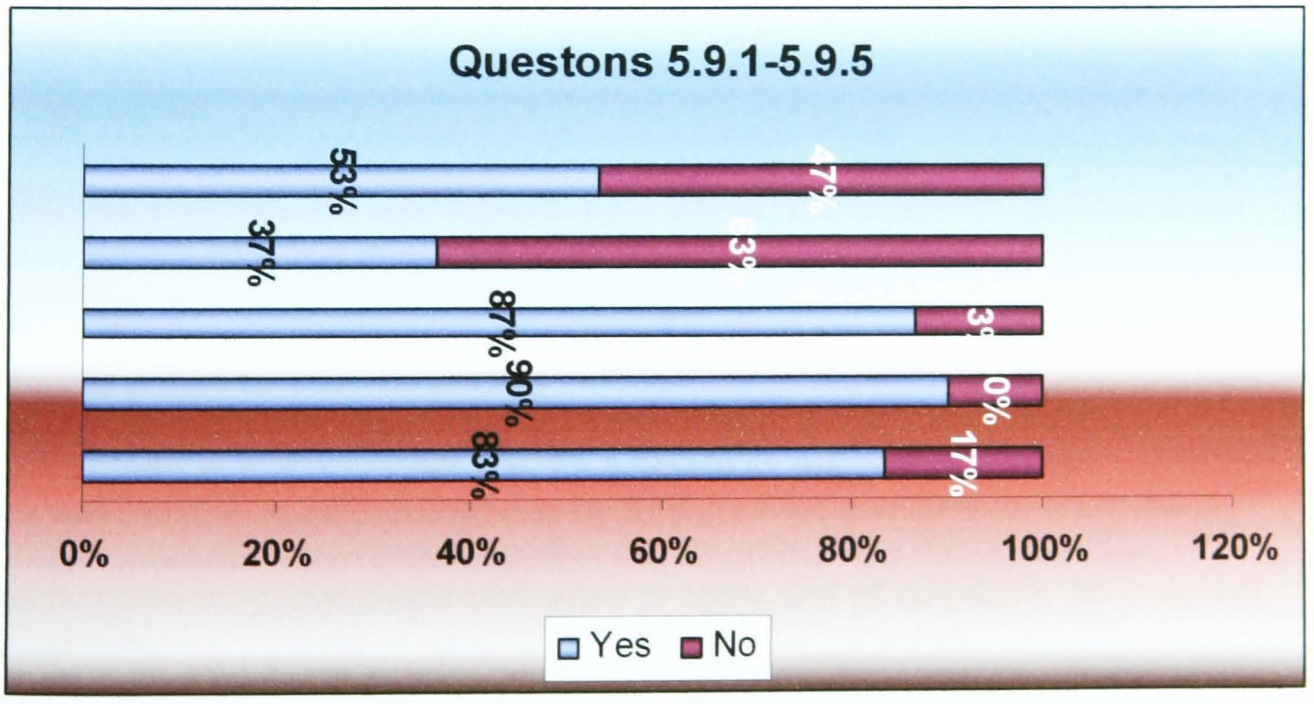


Table 6.52 Survey 1 Section 5 Part 5.9.1- 5.9.5 summaries

	5.1	5.2	5.3	5.4	5.9.1	5.9.2	5.9.3	5.9.4	5.9.5
SM2	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM3	N	N	N	N	Y	Y	Y	N	N
SM4	Y	Y	N	N	N	N	N	N	Y
SM5	N	N	N	Y	Y	Y	Y	Y	N
SM6	Y	Y	N	N	Y	Y	Y	N	Y
SM7	N	N	N	N	Y	Y	Y	N	N
SM8	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM9	Y	Y	N	N	Y	Y	Y	N	Y
SM10	N	N	N	N	N	Y	Y	N	N
SM11	Y	Y	N	Y	Y	Y	Y	Y	Y
SM12	Y	Y	Y	Y	N	N	N	Y	Y
SM13	N	N	N	N	Y	Y	Y	N	N
SM14	Y	Y	N	N	Y	Y	Y	N	Y
SM15	Y	Y	N	N	Y	Y	Y	N	Y
SM16	N	N	N	Y	Y	Y	Y	Y	N
SM18	Y	N	N	N	N	Y	N	N	N
SM19	N	N	Y	Y	Y	Y	Y	Y	N
SM20	Y	Y	N	N	Y	Y	Y	N	Y
CH4	N	N	N	N	Y	Y	Y	N	N
SM22	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM23	N	N	N	N	Y	Y	Y	N	N
SM24	Y	Y	Y	Y	N	N	N	Y	Y
SM25	N	N	N	N	Y	Y	Y	N	N
SM27	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM28	Y	Y	N	N	Y	Y	Y	N	Y
SM29	N	N	N	N	Y	Y	Y	N	N
SM30	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM31	N	N	N	N	Y	Y	Y	N	N
SM32	Y	Y	N	N	Y	Y	Y	N	Y
SM34	N	N	N	N	Y	Y	Y	N	N
Yes	57%	53%	27%	37%	83%	90%	87%	37%	53%
No	43%	47%	73%	63%	17%	10%	13%	63%	47%

Table 6.51 Survey 1 Section 5 Part 5.1- 5.9 summaries

Only three companies had implemented a bow tie diagram to structure a risk assessment plan and these are embodied bow tie diagrams in risk management manuals. In Part 5.10 participants in 90% doesn't implement bow tie diagrams. Since the system which are implemented and relative software uses bow tie diagrams bow tie was considered the most comprehensive approach in which also a full range of hazards, events and controls are shown. In Part 5.11 participants in 73% consider bow tie analysis as the best and most comprehensive approach followed by 37% for FTA and 27% for ETA. Semi Quantitative risk assessment by Bow Tie diagrams was considered by participants very useful and fairly easy to apply and all questions were replied positively.

There was a feeling that this is the dominant practical method could be used by ship managers for assessing operational risks and enhances maritime safety. In the below table is presented replies in questions regarding usefulness of semi quantitative methods.

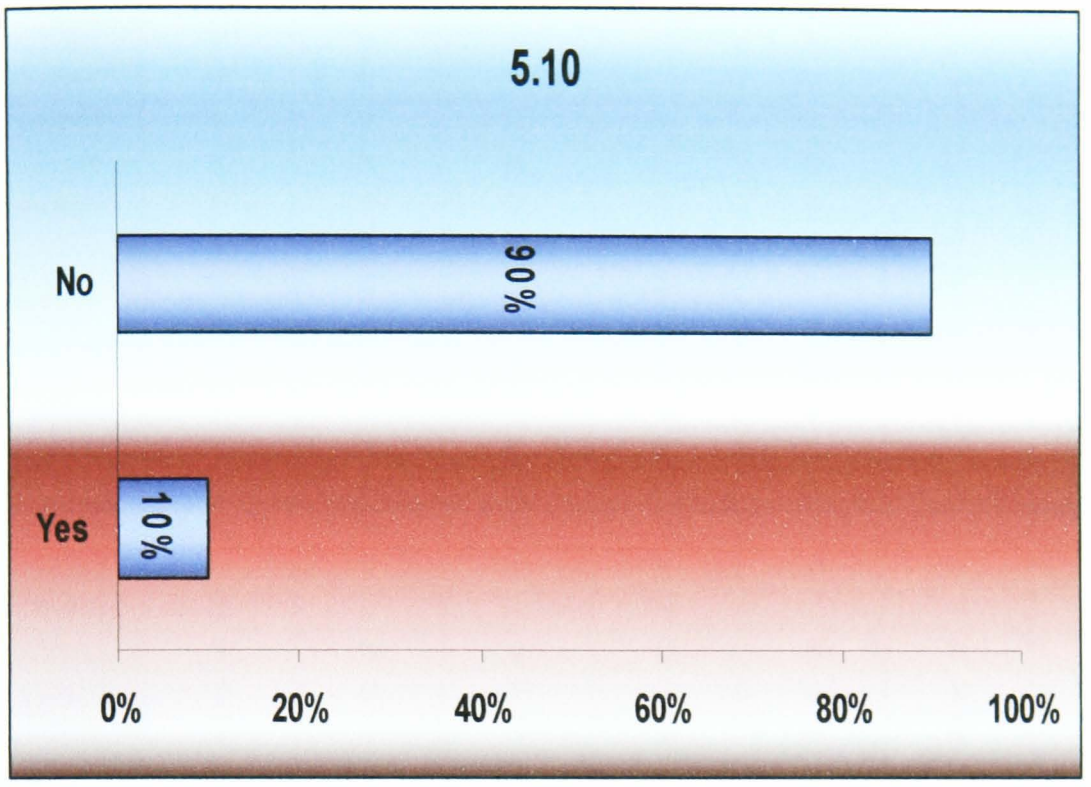


Table 6.52 Survey 1 Section 5 Part 5.10

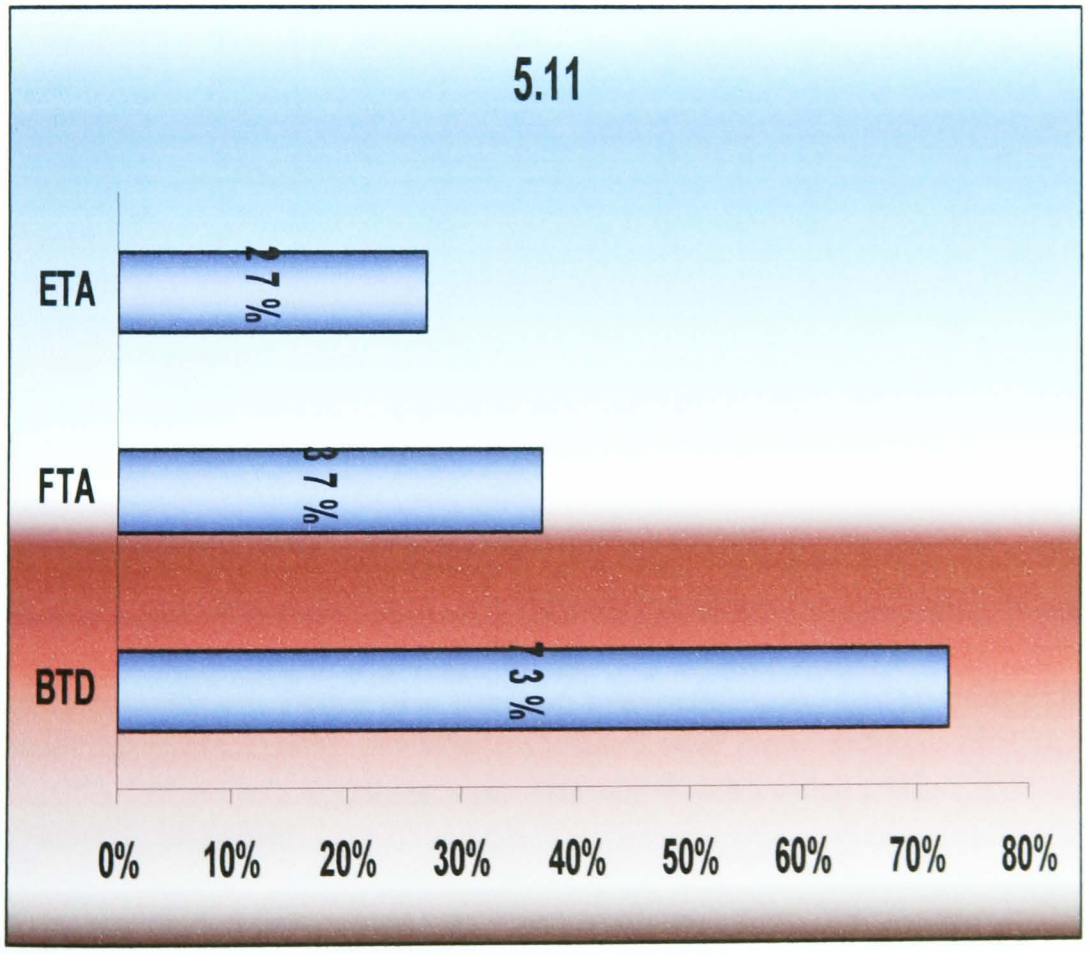


Table 6.53 Survey 1 Section 5 Part 5.11

5.12	1	2	3	4	5	6	7	8
SM2	Y	Y	Y	Y	Y	Y	Y	Y
SM3	Y	Y	Y	Y	Y	Y	Y	Y
SM4	Y	Y	Y	Y	Y	Y	Y	Y
SM5	Y	Y	Y	Y	Y	Y	Y	Y
SM6	Y	N	N	N	N	N	N	N
SM7	Y	Y	Y	Y	Y	Y	Y	Y
SM8	Y	Y	Y	Y	Y	Y	Y	Y
SM9	Y	Y	Y	Y	Y	Y	Y	Y
SM10	Y	N	Y	Y	Y	Y	N	Y
SM11	Y	Y	Y	Y	N	Y	Y	N
SM12	Y	Y	Y	Y	Y	Y	Y	Y
SM13	Y	Y	Y	Y	Y	Y	Y	Y
SM14	Y	N	N	N	N	N	N	N
SM15	Y	Y	Y	Y	Y	Y	Y	Y
SM16	Y	Y	Y	Y	Y	Y	Y	Y
SM18	Y	Y	Y	Y	Y	Y	Y	Y
SM19	Y	N	Y	N	N	N	N	N
SM20	Y	Y	Y	Y	Y	Y	Y	Y
CH4	Y	Y	Y	Y	Y	Y	Y	Y
SM22	Y	Y	Y	Y	Y	Y	Y	Y
SM23	Y	Y	Y	Y	Y	Y	Y	Y
SM24	Y	N	N	N	N	N	N	N
SM25	Y	Y	Y	Y	Y	Y	Y	Y
SM27	Y	Y	Y	Y	Y	Y	Y	Y
SM28	Y	Y	Y	Y	Y	Y	Y	Y
SM29	Y	Y	Y	Y	Y	Y	Y	Y
SM30	Y	Y	Y	Y	N	Y	Y	N
SM31	Y	Y	Y	Y	Y	Y	Y	Y
SM32	Y	Y	Y	Y	Y	Y	Y	Y
SM34	Y	Y	Y	Y	Y	Y	Y	Y
Yes	100%	83%	90%	87%	80%	87%	83%	80%
No	0%	17%	13%	10%	20%	10%	17%	20%

Table 6.54 Survey 1 Section 5 Part 5.12.1-8 summary

As previously noticed participants considered that beside quantitative methods maybe are of greater accuracy and confidence is not easily workable due to very limited data in various shipping and shipboard activities. The range of the existing data has great depth but referred to very limited areas which cannot be used in daily operations. None of a method had been used to the time of the survey between participants. Accident/ Incident and Near Misses/ Non conformity reports are widely used by ship managers and are a part of Management system's routines.

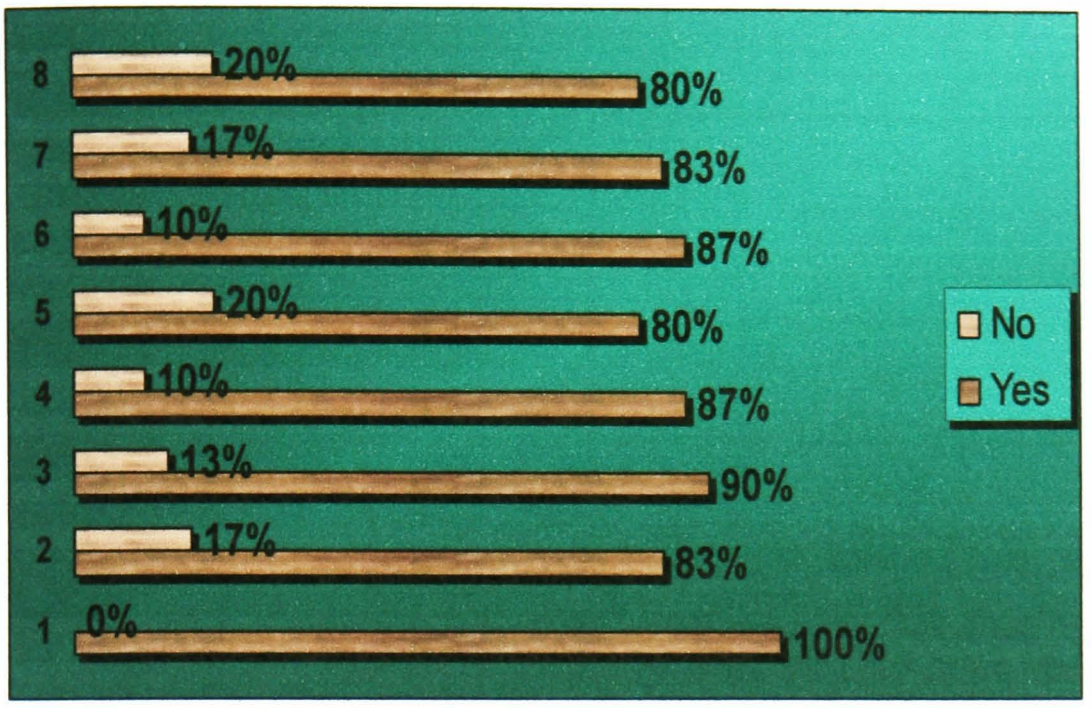


Table 6.55 Survey 1 Section 5 Part 5.12.1-8 summary

In Part 13 the responders evaluated quantitative methods and gave the following ranking presented in the table below.

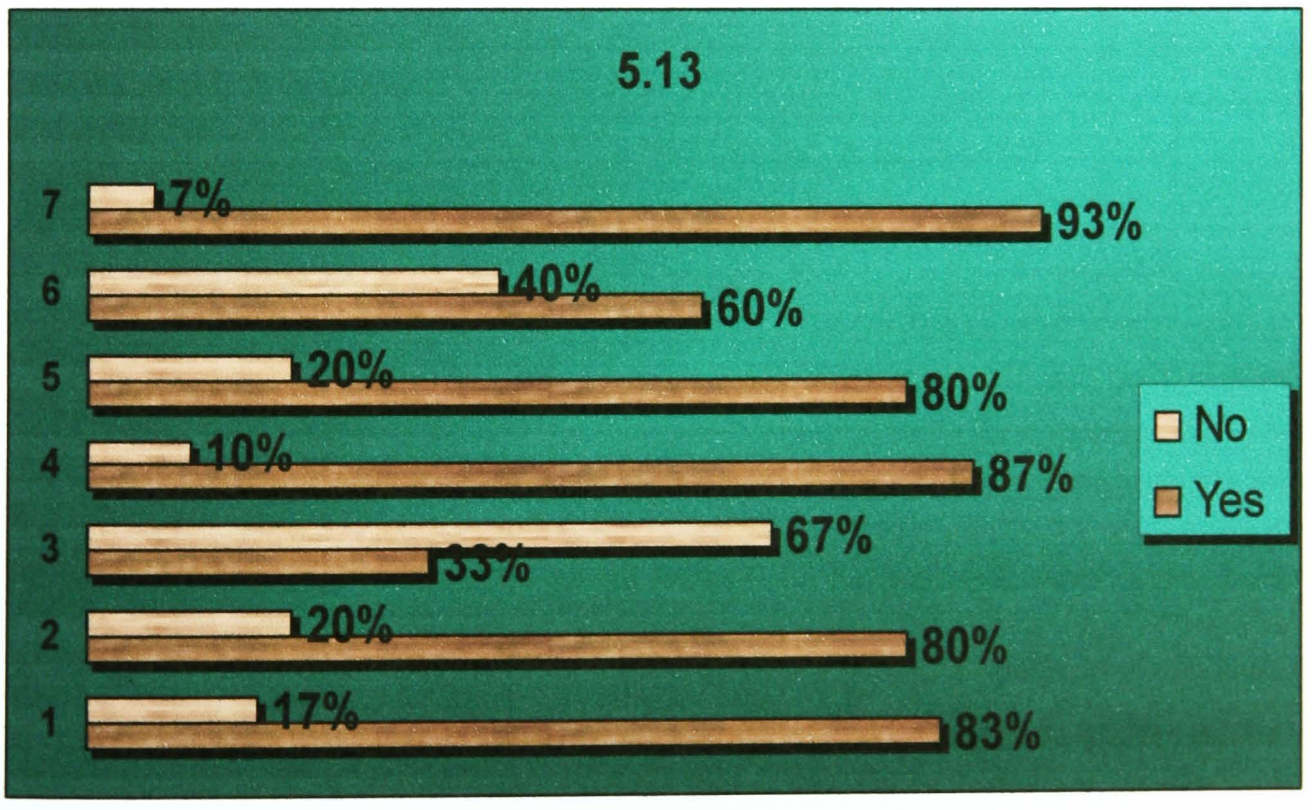


Table 6.56 Survey 1 Section 5 Part 5.13

5.13	1	2	3	4	5	6	7
SM2	Y	Y	Y	Y	Y	Y	Y
SM3	Y	Y	N	Y	Y	Y	N
SM4	N	Y	Y	Y	Y	Y	Y
SM5	Y	Y	N	Y	Y	N	N
SM6	Y	N	N	N	N	N	N
SM7	Y	Y	N	Y	Y	Y	N
SM8	N	Y	N	Y	Y	Y	N
SM9	Y	Y	Y	Y	Y	Y	Y
SM10	Y	N	N	Y	Y	Y	N
SM11	Y	Y	Y	Y	N	N	Y
SM12	Y	Y	N	Y	Y	Y	N
SM13	Y	Y	N	Y	Y	Y	N
SM14	N	N	N	N	N	N	N
SM15	Y	Y	N	Y	Y	Y	N
SM16	Y	Y	Y	Y	Y	Y	Y
SM18	Y	Y	Y	Y	Y	Y	N
SM19	Y	N	N	N	N	N	N
SM20	Y	Y	Y	Y	Y	Y	Y
CH4	Y	Y	N	Y	Y	Y	N
SM22	Y	Y	Y	Y	Y	Y	N
SM23	Y	Y	N	Y	Y	N	N
SM24	N	N	N	N	N	N	N
SM25	Y	Y	Y	Y	Y	Y	Y
SM27	Y	Y	N	Y	Y	N	N
SM28	Y	Y	N	Y	Y	N	N
SM29	Y	Y	Y	Y	Y	Y	Y
SM30	Y	Y	N	Y	N	N	N
SM31	N	N	N	N	Y	N	N
SM32	Y	Y	Y	Y	Y	Y	N
SM34	Y	Y	N	Y	Y	N	N
Yes	83%	80%	33%	87%	80%	60%	93%
No	17%	20%	67%	10%	20%	40%	7%

Table 6.57 Survey 1 Section 5 Part 5.13 summary

In part 5.14 the participants replied to the establishment of an accident reporting system in a positive part of 83% which mainly emanated by ISM implementation. That means that data is available for most of the companies participated, the question is if this data used for further analysis and decision making. This reply comes by the risk management implementation further in the next section. Five types of reports (Accident report, Near misses reports, Non conformity reports, Accident statistics report and Medical treatment cases report) were widely used by the participants and all were considered of high importance ranked by more than 70%.

5.14	A1	A2	A3	A4	A5	A6	A7	A8
SM2	Y	Y	Y	Y	Y	Y	Y	Y
SM3	Y	Y	N	Y	N	N	N	N
SM5	N	N	N	N	N	N	N	N
SM6	Y	Y	N	Y	Y	N	Y	Y
SM7	Y	Y	N	Y	Y	N	Y	Y
SM8	Y	Y	Y	Y	Y	Y	Y	Y
SM9	N	N	N	N	Y	N	Y	Y
SM11	Y	Y	Y	Y	N	Y	N	Y
SM13	Y	Y	N	Y	Y	N	Y	Y
SM14	Y	Y	N	Y	Y	N	Y	Y
SM15	Y	Y	N	Y	N	N	N	N
SM16	Y	Y	N	Y	Y	N	Y	Y
SM19	Y	Y	Y	Y	Y	Y	Y	Y
SM20	Y	Y	Y	Y	Y	Y	Y	Y
CH4	Y	Y	N	Y	N	N	N	N
SM22	Y	Y	Y	Y	Y	Y	Y	Y
SM23	Y	Y	N	Y	Y	N	N	Y
SM25	Y	Y	Y	Y	Y	Y	Y	Y
SM27	Y	Y	N	Y	N	N	N	N
SM28	N	N	N	N	N	N	N	N
SM29	Y	Y	Y	Y	Y	Y	Y	Y
SM30	Y	Y	N	Y	N	N	N	N
SM31	Y	Y	N	Y	N	N	N	N
SM32	Y	Y	Y	Y	Y	Y	Y	Y
SM34	Y	Y	N	Y	N	N	N	N
Yes	92%	92%	32%	92%	60%	36%	56%	64%
No	8%	8%	68%	8%	40%	64%	44%	36%

Table 6.58 Survey 1 Section 5 Part 5.14 summary

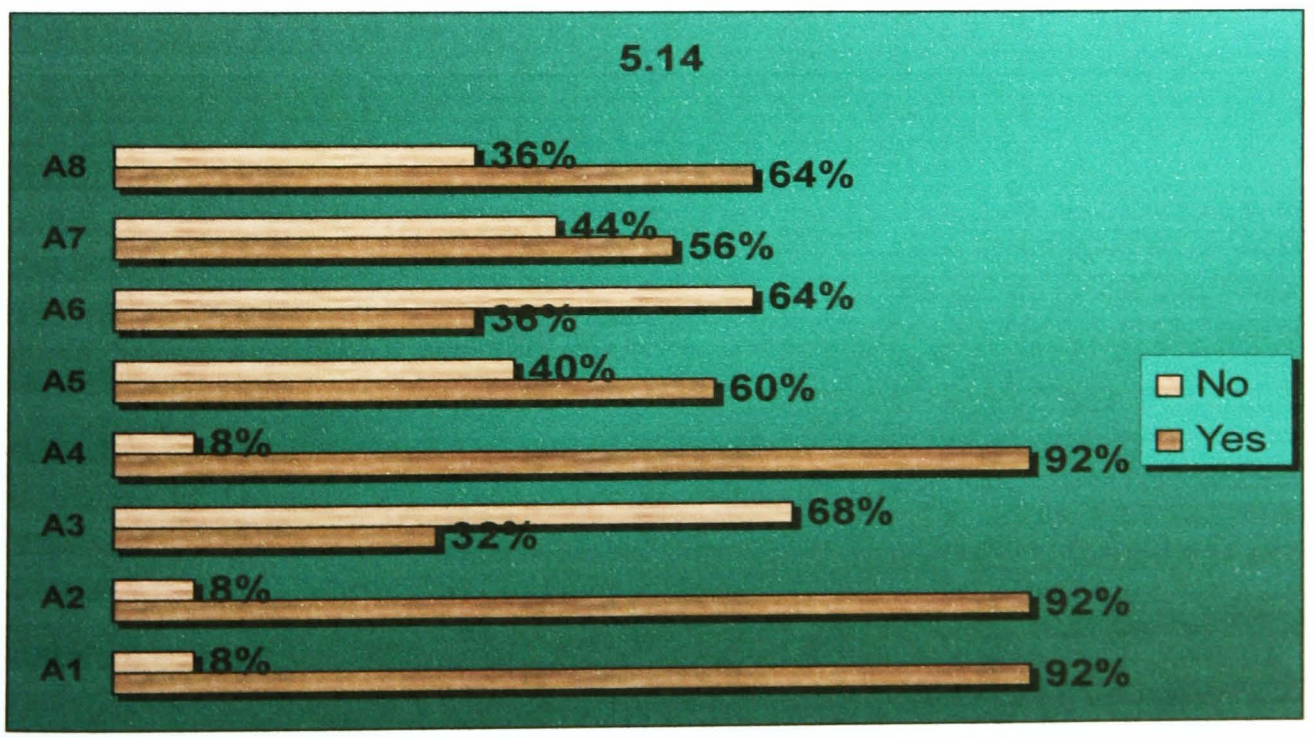


Table 6.59 Survey 1 Section 5 Part 5.14

The issue of significance to the interested parties brought to the Survey 1 the source for stakeholders' identification that mentioned in the Chapter 1 and

analytically presented. In Part 5.15 all participants replied that it is important to meet legislation and regulation requirements and also important is the concern to emergencies, to public by 93% and also to code of practice, demonstrable impact and stakeholders involved. The results strengthen the conditions researched for stakeholders involvement in risk management and decision making process. The results analytically presented in the table below.

5.15	A1	A2	A3	A4	A5	A6	A7	A8	A9
SM2	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM3	Y	N	N	Y	Y	Y	N	N	Y
SM4	Y	N	N	Y	Y	Y	N	N	Y
SM5	Y	N	Y	Y	Y	Y	Y	Y	Y
SM6	Y	N	N	Y	Y	Y	Y	Y	Y
SM7	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM8	N	N	N	Y	Y	N	Y	Y	N
SM9	Y	Y	Y	Y	Y	Y	N	Y	Y
SM10	Y	N	Y	Y	Y	Y	Y	Y	Y
SM11	Y	N	Y	Y	Y	Y	Y	Y	Y
SM12	Y	N	Y	Y	Y	Y	N	N	Y
5.15	A1	A2	A3	A4	A5	A6	A7	A8	A9
SM13	Y	N	Y	Y	Y	Y	Y	Y	Y
SM14	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM15	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM16	Y	N	N	Y	Y	Y	N	N	Y
SM18	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM19	Y	N	N	Y	Y	Y	N	Y	Y
SM20	Y	Y	Y	Y	Y	Y	Y	Y	Y
CH4	Y	Y	N	Y	Y	Y	N	N	Y
SM22	N	N	N	Y	Y	N	N	N	N
SM23	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM24	Y	Y	N	Y	Y	Y	N	N	Y
SM25	Y	N	N	Y	Y	Y	N	N	Y
SM27	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM28	Y	N	N	Y	Y	Y	N	N	Y
SM29	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM30	Y	N	N	Y	Y	Y	N	N	Y
SM31	Y	Y	N	Y	Y	Y	N	N	Y
SM32	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM34	Y	Y	Y	Y	Y	Y	N	Y	Y
Yes	93%	50%	57%	100%	100%	93%	90%	63%	93%
No	7%	50%	43%	0%	0%	7%	10%	37%	7%

Table 6.60 Survey 1 Section 5 Part 5.15 summary

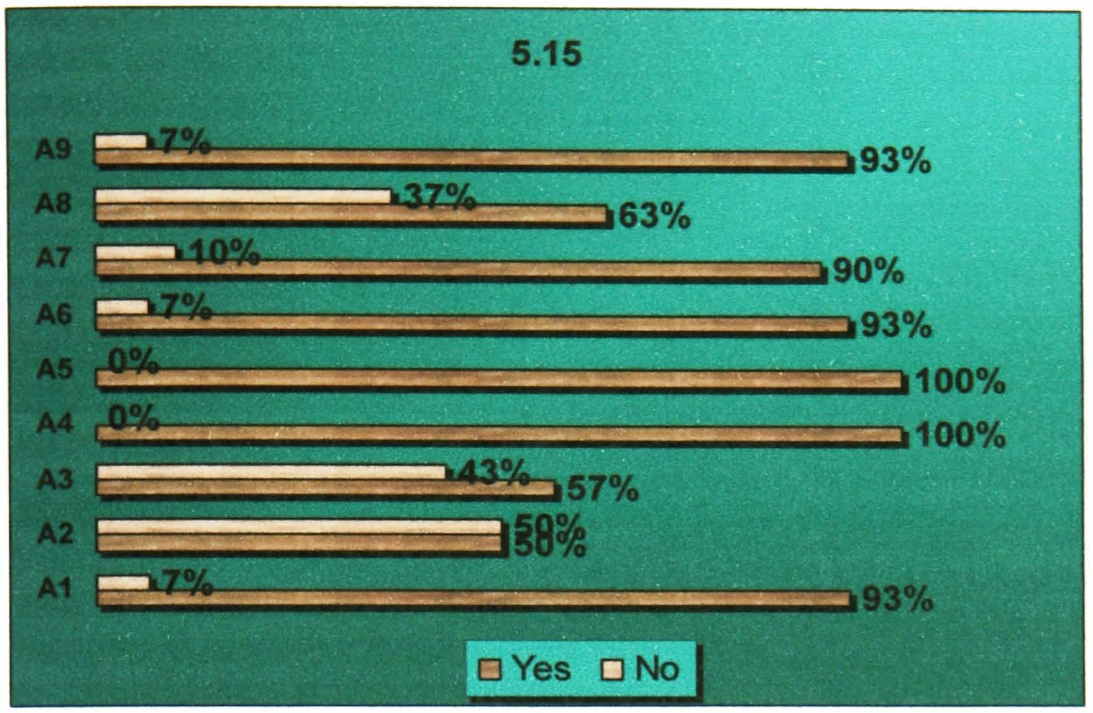


Table 6.61 Survey 1 Section 5 Part 5.15

All type of controls was selected mostly by participants as very important since significant impact of a top event could relate to each one of these for prevention or mitigation. The ranking of the control option in Part 5.16 is presented below.

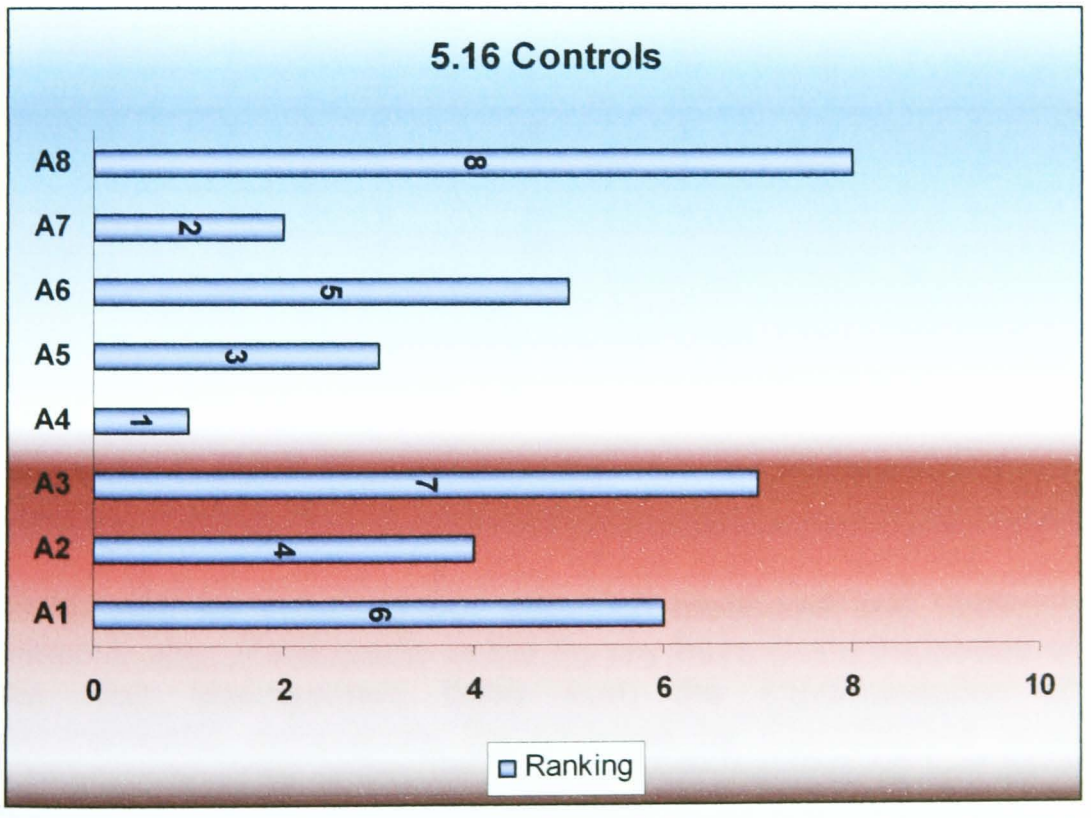


Table 6.63 Survey 1 Section 5 Part 5.16

5.16	A1	A2	A3	A4	A5	A6	A7	A8
SM2	7	6	4	1	5	2	3	8
SM3	5	4	6	1	3	8	2	7
SM4	6	3	5	1	2	8	4	7
SM5	6	2	8	5	4	1	3	7
SM6	6	2	8	3	4	1	5	7
SM7	7	4	6	1	2	5	3	8
SM8	7	6	4	1	5	2	3	8
SM9	5	4	6	1	3	8	2	7
SM10	6	3	5	1	2	8	4	7
SM11	6	2	8	5	4	1	3	7
SM12	6	2	8	5	4	1	3	7
SM13	6	2	8	3	4	1	5	7
SM14	7	4	6	1	2	5	3	8
SM15	7	6	4	1	5	2	3	8
SM16	5	4	6	1	3	8	2	7
SM18	6	3	5	1	2	8	4	7
SM19	6	2	8	5	4	1	3	7
SM20	6	2	8	3	4	1	5	7
CH4	7	4	6	1	2	5	3	8
SM22	7	6	4	1	5	2	3	8
SM23	5	4	6	1	3	8	2	7
SM24	6	3	5	1	2	8	4	7
SM25	6	2	8	5	4	1	3	7
SM27	6	2	8	5	4	1	3	7
SM28	6	2	8	3	4	1	5	7
SM29	7	4	6	1	2	5	3	8
SM30	7	6	4	1	5	2	3	8
SM31	5	4	6	1	3	8	2	7
SM32	6	3	5	1	2	8	4	7
SM34	6	2	8	5	4	1	3	7
Average	6.1	3.4	6.2	2.2	3.4	4.0	3.3	7.3
Ranking	6	4	7	1	3	5	2	8

Table 6.62 Survey 1 Section 5 Part 5.16 summary

Section 6 Risk Management

Part 6.1 to 6.6

In Survey 1 and within the steps of risk management, risk management is the fourth step for selecting risk reduction measures and implementing in a cost effective way. Participants in the survey have given the sense of awareness for the Risk Management firstly from the implementation of UR (Unified requirements) compulsory implemented by Classification societies and Flag Administrations for which selection of control measures and equipments is up to the ship managers and relative to the accrued cost of implementation and during Dry docking surveys where additional surface preparation and coating assessed without to be compulsory for enhancing cargo related safety and steel diminution. In Part 6.1 defined that the majority of the participants in 67 % haven't a formal risk management programme but 33 % has a system to identify and manage all risks involved. This provides an additional reason for the area of my research

since it dealt with an area which requires systematic risk management based on quality, safety, environmental and occupational health management system.

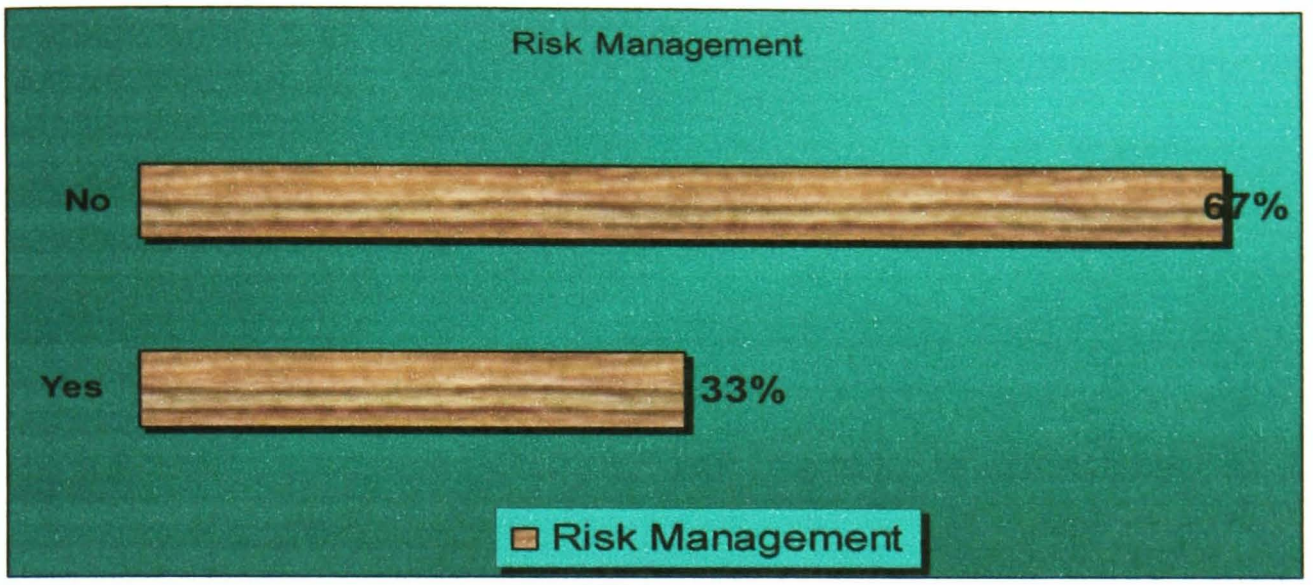


Table 6.64 Survey 1 Section 6 Part 6.1 Risk Management implementation

The participants considered that their companies implementing a risk management system to reduce risks to tolerable or acceptable level and an issue rose for discussion is to whom the level is acceptable or tolerable. The reply was mostly to the satisfaction of company unless regulatory or other official requirements are contrary to company's determined level. The reply for the risk acceptance criteria was positive for all participants and related to the general attitude of "think only positive and not be prepared unless happened" specifically when discussing human fatality. The participants considered that their company determined risk acceptance criteria for the related liabilities and replied positive taking into consideration mainly the criteria set by the Protection and Indemnity cover.

In Part 6.2 a part of 67% replied that risk acceptance criteria have been considered within company's framework of the implemented management system and only 33% has not set such criteria. Setting criteria is a very important procedure since supporting decision making process which is a major use of risk management.

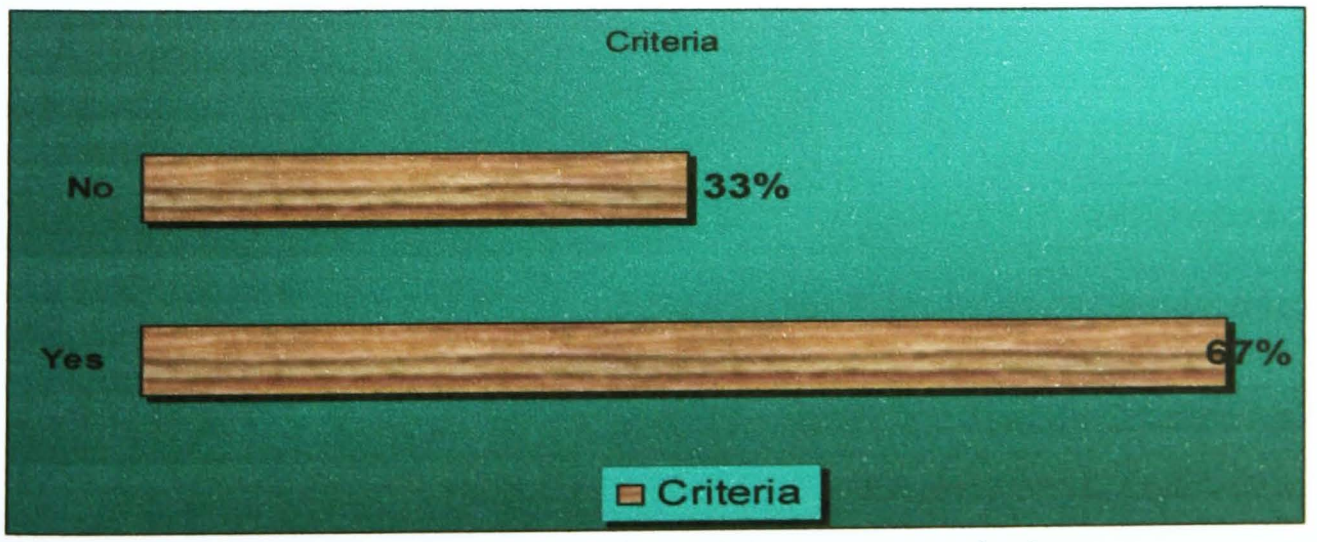


Table 6.65 Survey 1 Section 6 Part 6.2 Risk Management criteria

Risk criteria considered important for all conditions mentioned in the questions with most important that are essential to interpret results of risk assessment.
Generally as previous mentioned participants were reluctant to be involved when mentioned human fatality and that's why responded negatively in all such questions. Implied cost for averting fatality was only reluctantly considered by the participants when risks reduced to ALARP level.
Risk criteria are essential to all participants who agree with all statements questioned although doubts rose for unethical life valuation.

6.3	A1	A2	A3	A4	A5
SM2	Y	Y	Y	Y	Y
SM3	Y	N	Y	Y	Y
SM4	N	N	N	N	N
SM5	Y	Y	Y	Y	Y
SM6	Y	Y	Y	Y	Y
SM7	Y	Y	Y	Y	Y
SM8	Y	Y	Y	Y	Y
SM9	Y	Y	Y	Y	Y
SM10	N	N	N	N	Y
SM11	Y	Y	Y	Y	Y
SM12	N	N	N	N	N
SM13	N	N	Y	Y	Y
SM14	Y	Y	Y	Y	Y
SM15	Y	N	Y	Y	Y
SM16	Y	Y	Y	Y	Y
SM18	N	N	N	N	N
SM19	Y	Y	Y	Y	Y
SM20	Y	Y	Y	Y	Y
CH4	N	N	Y	N	Y
SM22	Y	Y	Y	Y	Y
SM23	Y	Y	Y	Y	Y
SM24	N	N	N	N	N
SM25	Y	Y	Y	Y	Y
SM27	Y	Y	Y	Y	Y
SM28	Y	Y	Y	Y	Y
SM29	N	N	Y	N	Y
SM30	Y	Y	Y	Y	Y
SM31	N	N	Y	Y	Y
SM32	Y	Y	Y	Y	Y
SM34	Y	Y	Y	Y	Y
Yes	70%	63%	83%	70%	87%
No	30%	37%	17%	30%	13%

Table 6.67 Survey 1 Section 6 Part 6.3 Risk criteria

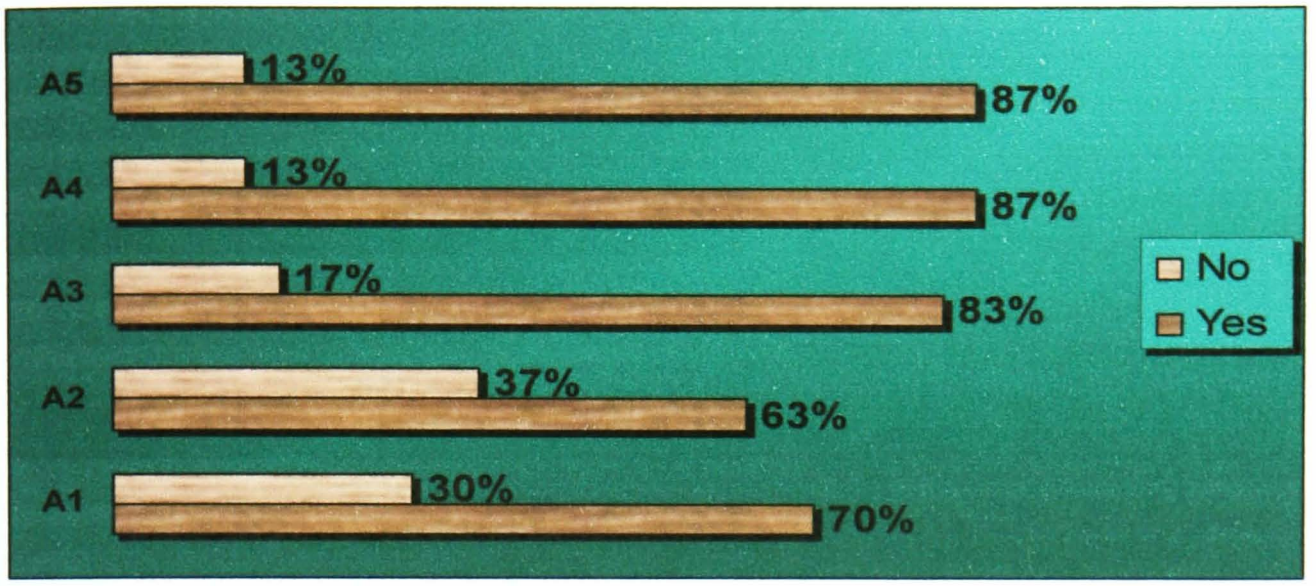


Table 6.66 Survey 1 Section 6 Part 6.3 Risk criteria

In Part 6.5 the participants replied in a part of 70% that CBA is taking into account cost and safety and by 63% that CBA is making the analysis explicit and traceable. Also by 83% consider that CBA standardizing investment cost in term of safety and by 70% participants consider that is best applicable to marine activities and the most important is that participants considered by 87% that CBA could be considered unethical when is carrying life valuation. The results are very important firstly because CBA is a part of Formal Safety Assessment which already tested in rule making process and considered a potential for risk based safety management, secondly is the main drive for allocation and utilization of recourses under the view of weak management areas pertinent to my research project.

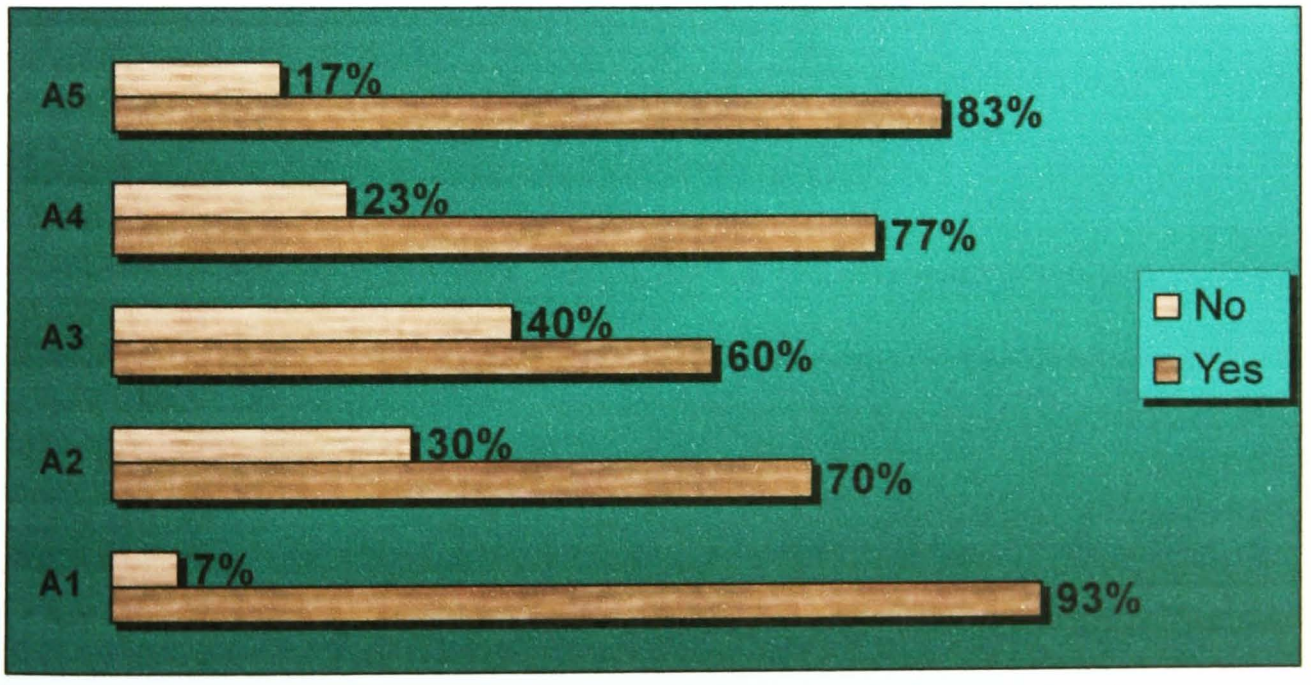


Table 6.69 Survey 1 Section 6 Part 6.5 Risk criteria questionnaire

6.5	A1	A2	A3	A4	A5
SM2	Y	Y	Y	Y	Y
SM3	Y	Y	N	Y	Y
SM4	Y	N	N	N	N
SM5	Y	Y	Y	Y	Y
SM6	Y	Y	Y	Y	Y
SM7	Y	Y	N	N	Y
SM8	Y	Y	Y	Y	Y
SM9	Y	Y	Y	Y	Y
SM10	Y	N	N	Y	Y
SM11	Y	Y	Y	Y	Y
SM12	Y	N	N	N	N
SM13	Y	Y	Y	Y	Y
SM14	Y	Y	N	Y	Y
SM15	Y	N	N	N	Y
SM16	Y	Y	Y	Y	Y
SM18	Y	N	N	N	N
SM19	Y	Y	Y	Y	Y
SM20	Y	Y	Y	Y	Y
CH4	Y	N	N	Y	Y
SM22	Y	Y	Y	Y	Y
SM23	N	Y	Y	Y	Y
SM24	Y	N	N	N	Y
SM25	Y	Y	Y	Y	Y
SM27	Y	Y	Y	Y	Y
SM28	Y	Y	Y	Y	Y
SM29	Y	N	N	Y	Y
SM30	Y	Y	Y	Y	Y
SM31	Y	N	N	Y	N
SM32	N	Y	Y	N	Y
SM34	Y	Y	Y	Y	N
Yes	93%	70%	60%	77%	83%
No	7%	30%	40%	23%	17%

Table 6.68 Survey 1 Section 6 Part 6.5 Risk criteria questionnaire

In Part 6.6 a part of 83% agreed to the use and scale of effectiveness and only 17% may have a different perception for the effectiveness of risk control options. Participants agreed positively to the scale presented as efficiency scale and cost scale for assessing control measures and positively agreed and considered very useful in prioritization the results scale 0.2-0.5 under which the highest the score the first should be implemented.

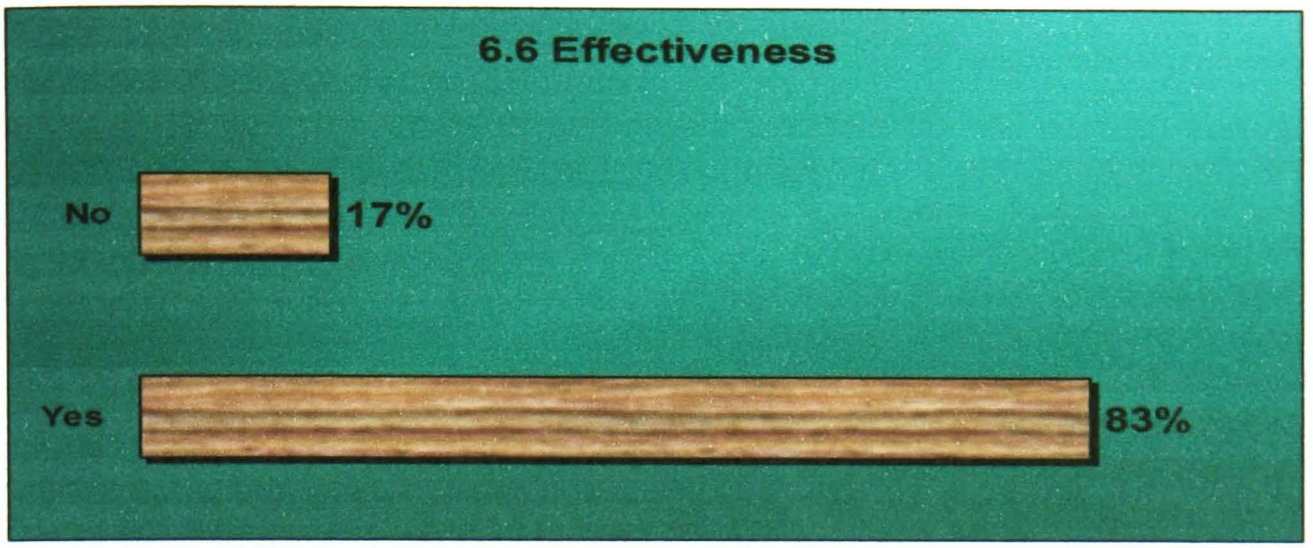


Table 6.70 Survey 1 Section 6 Part 6.6 Effectiveness of control options

	6.1	6.2	6.4	6.6
SM2	N	Y	A4	Y
SM3	N	N	N/A	Y
SM4	Y	Y	A3	N
SM5	N	Y	A4	Y
SM6	Y	Y	N/A	Y
SM7	N	N	N/A	Y
SM8	Y	Y	A3	Y
SM9	N	Y	N/A	Y
SM10	N	N	A4	N
SM11	Y	Y	N/A	Y
SM12	N	Y	N/A	N
SM13	N	N	N/A	Y
SM14	Y	Y	A4	Y
SM15	N	Y	N/A	Y
SM16	N	Y	N/A	Y
SM18	N	N	A4	N
SM19	N	Y	A4	Y
SM20	Y	Y	N/A	Y
CH4	N	N	N/A	Y
SM22	Y	Y	N/A	Y
SM23	N	N	N/A	Y
SM24	Y	Y	A4	N
SM25	N	N	A4	Y
SM27	Y	Y	A4	Y
SM28	N	Y	N/A	Y
SM29	N	N	N/A	Y
SM30	Y	Y	A3	Y
SM31	N	Y	N/A	Y
SM32	N	Y	A4	Y
SM34	N	N	A4	Y
Yes	33%	67%	A4	83%
No	67%	33%	N/A	17%

Table 6.71 Survey 1 Section 6 Part 6.1-6.6 summary

Section 7 Risk Auditing and Self Assessment
Part 7.1 to 7.5

In Survey 1 and within the steps of risk management, risk auditing and self assessment is last step for monitoring and reviewing the proper implementation and effectiveness of risk management system. Participants in the survey have given the sense of awareness for the Risk Auditing firstly from the implementation of ISM and ISO audits which are compulsory implemented by Certification bodies and second from the accident-incident investigation by the relative authorities. In Part 7.1 a part of 90% replied that there is an implemented auditing system and only 10% replied that there is not any auditing and self assessment system available in their companies. In Part 7.2 a part of 97% replied that their companies have a plan for internal audits to review and monitor results of inspections which means that ISM auditing is fairly implemented. In Part 7.3 a part of 93% replied positively that there is training plan involving issues of risk management. Positive replies delivered from the participants for audit plans and training for the same reasons as previously presented.

	7.1	7.2	7.3
SM2	Y	Y	Y
SM3	Y	Y	Y
SM4	Y	Y	Y
SM5	Y	Y	Y
SM6	Y	Y	Y
SM7	N	Y	N
SM8	Y	Y	Y
SM9	Y	Y	Y
SM10	N	Y	Y
SM11	Y	Y	Y
SM12	Y	Y	Y
SM13	Y	Y	Y
SM14	Y	Y	Y
SM15	Y	Y	Y
SM16	Y	Y	Y
SM18	Y	Y	Y
SM19	Y	Y	Y
SM20	Y	Y	Y
CH4	N	N	N
SM22	Y	Y	Y
SM23	Y	Y	Y
SM24	Y	Y	Y
SM25	Y	Y	Y
SM27	Y	Y	Y
SM28	Y	Y	Y
SM29	Y	Y	Y
SM30	Y	Y	Y
SM31	Y	Y	Y
SM32	Y	Y	Y
SM34	Y	Y	Y
Yes	90%	97%	93%
No	10%	3%	7%

Table 6.73 Survey 1 Section 7 Part 7.1-7.3 Risk Auditing

Table 6.72 Survey 1 Section 7 Part 7.1-7.3 Risk Auditing

According to the replies in Part 7.4 the most suitable risk manager ashore is the designated person ashore with positive opinion of 70 per cent followed by a senior manager within the company. As far as regard duties onboard the most suitable was considered by participants for the Master by 53 percent Chief Officer with 27 percent followed by Safety Officer with 13 per cent.

7.4	A1	A2	A3	A4	A5	A6	A7	A8
SM2	Y				Y			
SM3	Y					Y		
SM4	Y				Y			
SM5		Y				Y		
SM6				Y			Y	
SM7	Y				Y			
SM8		Y				Y		
SM9	Y				Y			
SM10			Y				Y	
SM11	Y				Y			
SM12	Y				Y			
SM13	Y				Y			
SM14		Y				Y		
SM15	Y				Y			
SM16	Y					Y		Y
SM18	Y							
SM19	Y				Y			
SM20		Y				Y		
CH4	Y				Y			
SM22	Y							Y
SM23	Y				Y			
SM24		Y					Y	
SM25	Y					Y		
SM27	Y				Y			
SM28	Y				Y			
SM29			Y			Y		
SM30	Y				Y			
SM31	Y				Y			
SM32		Y					Y	
SM34	Y				Y			
Yes	70%	20%	7%	3%	53%	27%	13%	7%

Table 6.74 Survey 1 Section 7 Part 7.1-7.3 Risk Auditing

In Part 7.5 participants were replied to the Stakeholder's significance with different opinions putting in the most significant group Publicity and media by

90%, followed by Port authorities in a part of 87%, Activists in a part of 83%, Insurance companies and P+I clubs in a part of 77% and 80% respectively, and Classification Societies, Ship owners managers and Charterers without to reduce for the last the significance level below to the very important level.

7.5	A1	A2	A3	A4	A5	A6	A7	A8	A9
SM2	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM3	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM4	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM5	Y		Y	Y	Y	Y	Y	Y	Y
SM6	Y		Y	Y	Y	Y	Y	Y	Y
SM7	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM8					Y		Y	Y	
SM9		Y			Y				Y
SM10	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM11		Y		Y	Y				Y
SM12	Y		Y	Y	Y	Y	Y	Y	Y
SM13	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM14									Y
SM15	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM16	Y		Y	Y	Y	Y	Y	Y	Y
SM18	Y	Y	Y	Y	Y			Y	Y
SM19	Y		Y	Y	Y		Y	Y	Y
SM20		Y				Y	Y		
CH4	Y		Y	Y	Y		Y	Y	Y
SM22	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM23	Y	Y		Y	Y	Y		Y	Y
SM24			Y				Y	Y	
SM25	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM27	Y	Y	Y	Y	Y	Y		Y	Y
SM28	Y	Y	Y	Y	Y	Y		Y	Y
SM29						Y	Y		Y
SM30	Y	Y	Y	Y	Y		Y	Y	Y
SM31	Y	Y	Y	Y	Y	Y	Y	Y	Y
SM32			Y	Y	Y	Y	Y	Y	Y
SM34	Y		Y	Y	Y			Y	Y
Yes	73%	60%	77%	80%	87%	67%	73%	83%	90%
Rank	7	9	5	4	2	8	6	3	1

Table 6.76 Survey 1 Section 7 Part 7.1-7.3 Risk Auditing

Section 8 General Questions
Part 8.1 to 8.3

In the Survey 1 Rev.2 I have added a general questionnaire for the investigation of easy could be applied risk based management to the ship management companies and their staff. The vast majority of participants considered that could easily apply Operational risk management and Formal safety assessment focusing mainly qualitative approach.

	8.1	8.2	8.3
SM2	Y	Y	Y
SM3	Y	N	N
SM4	N	N	Y
SM5	Y	Y	N
SM6	Y	N	N
SM7	Y	N	N
SM8	Y	Y	N
SM9	Y	N	N
SM10	Y	Y	Y
SM11	N	N	N
SM12	Y	N	N
SM13	N	N	N
SM14	Y	N	N
SM15	N	Y	Y
SM16	Y	N	N
SM18	Y	N	N
SM19	Y	Y	N
SM20	Y	Y	Y
CH4	N	N	N
SM22	Y	N	N
SM23	Y	N	Y
SM24	Y	N	Y
SM25	Y	N	N
SM27	N	Y	Y
SM28	Y	N	N
SM29	Y	N	N
SM30	Y	Y	Y
SM31	Y	N	N
SM32	Y	N	N
SM34	Y	Y	Y
Yes	80%	33%	30%
No	20%	67%	70%

For the same reason the participants did not consider that additional or unreasonable costs will be spend for such implementation in Safety Quality Environmental protection and Occupational health and Safety systems and their total reply was negative. The majority also considered negatively the option of compulsory implementation promptly of the Formal Safety assessment in managing ships since first needed proper familiarization and training and also testing period. The majority also considered positively the implementation of FSA in 3-5 years period for Tankers, Chemicals and Gas Carriers and 5-10 years for the rest type of ships.

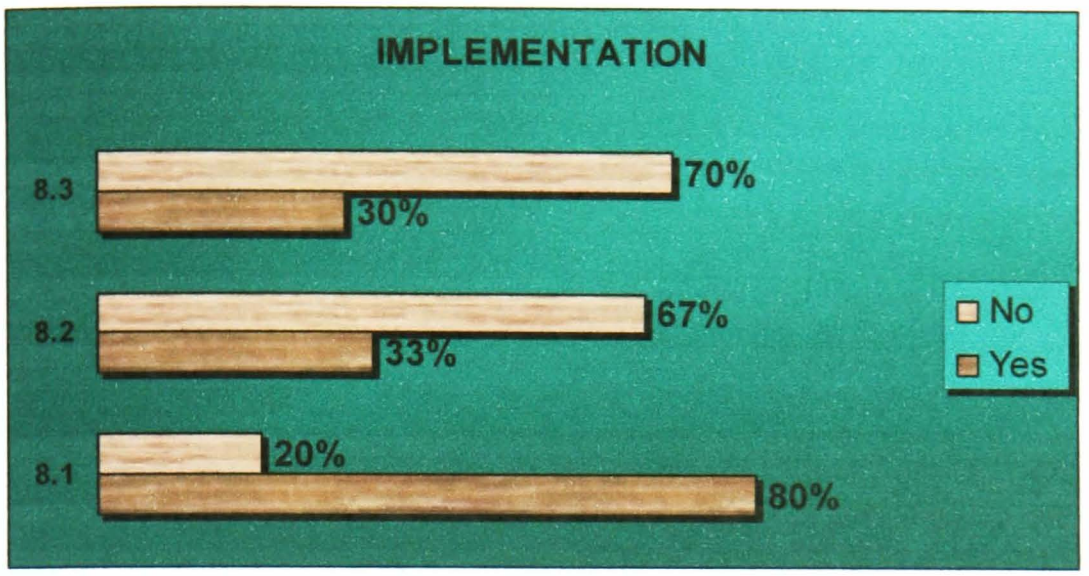


Table 6.78 Survey 1 Section 8 Part 8.1-8.3 Risk Implementation

Conclusions of Survey 1

The Survey 1 is considered a survey of verification for the existing conditions, awareness and knowledge of Risk Management methods and factors which interact for the establishment of Maritime risk management system. There have been identified during the survey that there are a lot already good and professional management companies trying to establish and link risk management to the implemented management system and some of these succeeded already to implement on day to day operations. Three characteristics are of particular concern in this research survey, awareness – common metrics and implementation. In the survey, responders were asked to provide information about the level of these characteristics and by those knowledge outcomes a set of case studies and areas of research auditing determined. It has also provided responses to a potential new implemented or amended safety management system and made evaluation of them. It has also enhanced communication with participants representing a reliable sample through whom a risk based management and decision making investigated and developed based in the existing quality, safety, environmental and occupational health management systems. It has also enhanced responsibility for self and others by replying critical questions related to incidents to life, property, environment and reputation by the same talking of ethical understanding. Table below summarizes the main conclusions and achievements in the Survey 1 and relative information from the appendices. The research approach in Survey 1 is exploratory; further applications of the shipping activities risk management approach and the qualification processes were needed as to evaluate the contribution of the Survey 1 in the risk management field. This was covered by the followed Case studies were more detailed examination made. Especially the level of risk awareness at all stages and importance of implementation of risk management have been extensively reviewed.

Sectional achievements from Survey 1	
Section 1	The Section 1 sets the profile of the participants their capacity and main categories creating a data base with considerable importance relative to my project. Ship managers were the majority of the participants with substantial experience of average 10 yrs. ISM and ISO 9001 are the most applicable systems by the participants. Eight (8) types of ships selected for the survey's analysis Bulk Carriers, Chemical Tankers, Gas Carriers, Car Carriers, Oil Tankers, Reefers and Containers
Section 2	The Section 2 sets the profile of the type and size of ships owned and managed by participants. It was concluded that medium sized companies prevail in the survey which indicates that the cross section of sample was formed from a good diversification of ships. The average age of 15 years for participant's fleet considered representative for risk contribution with considerable importance relative to my project.
Section 3	The Section 3 sets the achievements by the Survey1 in level of Hazard Identification developments in a broader perspective by referencing to selected techniques in the area of maritime management and awareness of causation categories and chain. Section 3 also furthers the developments by introducing a list of shipping and shipboard activities for all 8 types of ships in which hazards applied in a process model of the qualification of risk management.
Section 4	The Section 4 sets the achievements of the Survey1 in level of awareness and introduction of the concept of precautionary risk analysis referencing to selected methods and parameters in the area of maritime management. The roles of impact categories and location parameter, model and implementation awareness are discussed from the point of view of importance verification of risk analysis. The concept of qualification and quantification of risk analysis is also introduced. It entails a conceptual framework for communicating quality-related properties of risk assessment. Also a list of maritime incidents and aspects has created on the use of selection of top events in order to determine an initial judgment of importance.
Section 5	The Section 5 sets the achievements of the Survey1 in level of awareness and introduction of the concept of risk assessment methods referencing to selected indices for frequency and severity parameters. Formal Safety Assessment guidance was applied to establish severity indices for human fatalities and

	relatively additionally relative elements added to assess and evaluate the safety and environmental incidents for severity. The research results convinced that this combination and use of International Maritime Organisation guidance for risk index in combination with actions and timescale proposed by the participants give confidence and support for risk assessment implementation. The methodological framework of Bow Tie diagrams was considered the most suitable for risk control options determination and interrelation between participants. Also a list of risk control options and stakeholders has created on the use of risk assessment in order to determine an initial judgment of consequence importance.
Section 6	The Section 6 sets the achievements of the Survey1 in level of awareness and introduction of the concept of risk management methods referencing to selected criteria as to acceptability of risk and efficiency vs. cost relation of risk reduction measures. Participants were reluctant to address valuation of risk to human life but based on ALARP principal it was developed a correlation to support the decision-maker in defining incentives to reach consensus decisions in this specified decision context. Participants defined that ICAF level determined as incorporated in compensation covered by the protection and indemnity insurance for specific conditions and cases. Risk control options efficiency and cost guidance was applied to establish efficiency indicators for prioritisation of implementation based in cost benefit analysis.
Section 7	The Section 7 sets the achievements of the Survey1 in level of self assessment and review preparing a proper and efficient risk management implementation. Risk gap analysis and assignment of risk duties introduced that makes possible the use of collected information in the form of non conformities, accident incident reports and near misses to values which can further examined and used for prediction models.
Section 8	The Section 8 sets the results for confidence of easy implementation of a risk management system and defines a period of 5 years as minimum time scale needed.

Table 6.79 Survey 1 Sectional achievements

6.2 Survey 2

General Characteristics

The Survey 2 derived in two parts 1 and 2. The completed responses I received finally were 32 replies which were used for data evaluation and analysis. This represents 8 case studies in 40 companies/ship's type.

BULK CARRIERS	9
CAR CARRIERS	3
CHEMICALS	3
CONTAINERS	5
GAS CARRIERS	4
GENERAL	4
OIL TANKERS	6
REEFERS	6

Table 6.2.1 Survey 2 Case studies

Part 1

As noted in Chapter 5 in the first Part 1 the responders asked to give opinion of how activities with associated hazards affect probability of a failure by causes in an implemented management system. The participants also asked to provide level of confidence of the exposure for their estimates. Data is provided by ship's type and summary of each type of ship for Safety, Quality, Environmental and Occupational Health is presented for the probability estimation of an incident in relation with causation for shipping activities. Additionally the summary of each ship's type presented in Appendix due to vast amount of data and limited space of the project's report. Results in summaries should not be undermined, beside are not presented here which also are the benchmark of the project's results. Below presented the ranking emanated by Management System probability of an incident for each Safety, Quality, Environmental and Occupational Health for an incident caused by one of the direct or indirect causes and the level of confidence for the exposure. The result emanated by the formula SRI (Success Risk Index) = P^n (Possibility for an incident by prevailing cause)* C^n (Confidence of exposure).

As discussed in Chapter 5 earlier shipping activities are ranked and prioritized per safety, quality, environmental and occupational health criteria and also ranked for the probability of an incident by certain cause category. These variables could be used as variables for determining risk level of success and it gives a reliable indication of risk assessment results used for risk management respectively. In order to correlate SRI of shipping and shipboard activities with RI the results could be considered independed variables for correlation analysis among causes incident probability and risk index which will provide the correlation of predicting an incident by a certain level of cause rating. Cause rating improved by the provision of additional control measures if necessary and is technical, procedural, human or managerial. This information provided in the second Part 2 of the Case studies.

FINAL RANKING

NO	SFTY SRI	QTY SRI	ENV SRI	OHS SRI	EXP	UA	UC	HF	TF
A1	3.44	9.03	3.11	3.00	23.13	9.52	24.98	8.60	8.30
A2	3.40	8.59	3.30	3.11	24.59	8.85	22.35	8.60	8.10
A3	5.14	12.37	4.57	4.23	26.87	12.23	29.47	10.88	10.07
A4	3.10	8.12	3.29	3.06	24.48	8.10	21.22	8.60	8.00
A5	3.78	9.96	3.57	3.40	26.87	9.00	23.73	8.50	8.10
A6	3.34	7.38	3.25	3.06	24.46	8.75	19.32	8.50	8.00
A7	3.27	9.18	3.30	2.90	23.23	9.02	25.28	9.10	8.00
A8	3.15	8.15	3.08	3.05	24.37	8.27	21.40	8.10	8.00
B1	3.72	8.74	3.24	3.48	24.83	9.60	22.52	8.35	8.97
B2	3.55	9.89	3.39	3.19	25.49	8.92	24.83	8.50	8.00
B3	3.74	10.70	3.35	3.35	26.83	8.92	25.52	8.00	8.00
B4	3.61	8.88	3.44	3.24	25.88	8.92	21.97	8.50	8.00
B5	3.29	9.05	3.29	3.29	26.31	8.00	22.02	8.00	8.00
B6	4.00	10.69	3.59	3.57	26.89	9.52	25.45	8.55	8.50
B7	3.35	8.49	3.24	3.39	25.59	8.38	21.23	8.10	8.47
B8	3.52	10.01	3.74	3.52	28.19	8.00	22.72	8.50	8.00
B9	3.31	9.12	3.24	3.36	25.59	8.27	22.80	8.10	8.40
B10	3.23	7.69	3.08	2.94	23.19	8.92	21.23	8.50	8.10
B11	3.77	9.85	3.59	3.59	27.02	8.92	23.32	8.50	8.50
B12	3.27	10.28	3.27	3.25	26.00	8.05	25.30	8.05	8.00
B13	3.31	7.29	3.44	3.32	25.63	8.27	18.22	8.60	8.30
C1	3.96	7.62	4.05	3.20	25.32	10.00	19.25	10.25	8.10
C2	3.82	8.24	3.82	3.30	26.44	9.25	19.95	9.25	8.00
C3	3.74	8.31	3.43	3.29	25.36	9.43	20.97	8.65	8.30
C4	3.72	7.60	3.59	3.35	25.23	9.43	19.28	9.10	8.50
C5	8.03	7.12	5.38	5.46	24.65	20.85	18.50	13.97	14.17
C6	9.74	9.09	5.20	5.40	25.61	24.33	22.72	13.00	13.50
C7	9.68	8.74	5.50	6.38	26.56	23.33	21.07	13.25	15.37
C8	4.02	8.33	4.45	3.47	27.78	9.25	19.20	10.25	8.00
D1	9.11	8.20	5.23	7.38	23.90	24.40	21.95	14.00	19.77
D2	8.79	8.45	6.93	7.19	25.62	21.97	21.10	17.32	17.97
D3	9.71	9.36	8.21	4.36	25.34	24.52	23.63	20.73	11.00
D4	9.83	9.70	8.77	5.64	27.21	23.12	22.82	20.63	13.27
D5	4.09	8.67	7.36	6.84	26.86	9.75	20.65	17.53	16.30
D6	9.61	8.25	3.16	5.36	25.28	24.33	20.88	8.00	13.57
D7	9.81	8.28	4.21	4.42	27.19	23.08	19.48	9.90	10.40
D8	10.67	8.81	4.39	3.66	29.26	23.35	19.27	9.60	8.00
D9	10.00	8.39	5.66	3.19	25.49	25.12	21.07	14.22	8.00
D10	8.75	9.84	3.55	5.56	28.42	19.72	22.17	8.00	12.53
D11	9.47	8.15	3.01	3.01	24.10	25.15	21.65	8.00	8.00
D12	9.00	7.56	3.37	3.31	24.95	23.08	19.40	8.65	8.50
D13	10.61	8.27	3.20	3.53	23.83	28.48	22.22	8.60	9.47
D14	10.67	8.69	5.55	4.37	25.43	26.85	21.87	13.97	11.00
E1	8.14	8.63	5.11	4.26	23.40	22.27	23.60	13.97	11.65
E2	7.92	8.24	3.56	3.65	24.60	20.62	21.43	9.25	9.50
E3	8.87	8.69	3.69	3.88	25.50	22.27	21.82	9.25	9.75
E4	8.27	8.99	3.69	8.01	24.48	21.62	23.50	9.65	20.93
E5	12.00	7.75	10.49	7.61	23.15	33.18	21.42	29.00	21.03
E6	9.79	7.97	4.07	8.93	26.28	23.83	19.42	9.90	21.73
E7	9.41	9.00	8.10	8.55	25.53	23.58	22.57	20.30	21.43
E8	9.04	9.37	7.57	8.95	27.94	20.72	21.47	17.35	20.50
F1	10.50	9.50	12.33	8.84	27.20	24.70	22.35	29.00	20.80
F2	9.46	7.96	10.86	8.00	23.96	25.28	21.27	29.00	21.37
F3	9.14	8.97	11.87	8.52	26.21	22.32	21.90	29.00	20.80
F4	8.67	8.85	3.37	7.93	24.91	22.27	22.73	8.65	20.37
F5	8.40	7.75	8.04	8.38	26.00	20.67	19.08	19.80	20.63
F6	9.16	7.33	7.13	9.22	26.32	22.27	17.82	17.35	22.43
F7	7.55	7.28	7.02	7.52	23.43	20.62	19.88	19.17	20.53
F8	12.83	8.77	7.51	9.84	25.08	32.73	22.37	19.17	25.10
G1	8.55	8.83	9.48	7.91	24.53	22.32	23.05	24.75	20.63
G2	8.99	7.96	8.17	9.07	25.85	22.27	19.70	20.22	22.47
G3	9.92	8.50	10.33	10.04	25.44	24.97	21.40	25.98	25.27
G4	10.70	8.39	11.29	11.09	27.69	24.73	19.40	26.08	25.63
G5	8.95	4.42	3.30	8.92	25.71	22.27	11.00	8.22	22.20
G6	8.15	6.33	3.04	8.00	24.36	21.42	16.63	8.00	21.03
H1	9.17	8.28	2.98	7.58	23.20	25.28	22.85	8.22	20.90

H2	8.78	7.84	3.15	10.01	25.18	22.32	19.92	8.00	25.43
H3	9.83	8.67	3.62	11.32	28.18	22.32	19.70	8.22	25.70
H4	8.67	7.23	2.74	8.61	21.95	25.28	21.08	8.00	25.10
H5	8.91	7.45	3.00	9.04	23.40	24.38	20.37	8.22	24.73
H6	10.04	7.65	2.98	9.86	23.84	26.95	20.53	8.00	26.47
H7	10.38	9.02	3.37	9.95	26.27	25.28	21.98	8.22	24.23
H8	7.50	7.00	2.69	8.82	21.51	22.32	20.82	8.00	26.23
H9	8.31	7.97	3.05	7.82	23.77	22.37	21.47	8.22	21.07
H10	7.41	7.49	2.94	7.54	22.94	20.67	20.90	8.22	21.03
H11	10.51	7.80	4.50	10.43	26.61	25.28	18.77	10.83	25.10
H12	10.52	8.48	7.67	10.62	25.67	26.22	21.13	19.12	26.47
H13	9.66	9.10	3.46	9.01	27.71	22.32	21.02	8.00	20.80
H14	10.51	7.83	3.94	10.44	26.61	25.28	18.83	9.47	25.10
H15	9.17	7.73	3.29	8.48	26.30	22.32	18.82	8.00	20.63
H16	10.04	8.60	3.87	11.25	26.08	24.63	21.10	9.50	27.60
H17	8.24	7.62	3.28	8.72	25.51	20.67	19.12	8.22	21.87
H18	9.50	7.05	3.49	10.65	24.04	25.28	18.78	9.30	28.37
H19	8.66	7.93	3.59	9.30	24.83	22.32	20.43	9.25	23.97
H20	9.27	7.33	3.54	8.38	25.99	22.82	18.05	8.72	20.63
H21	10.13	7.48	4.37	10.05	25.63	25.28	18.68	10.92	25.10
H22	8.25	6.58	3.51	9.05	23.65	22.32	17.82	9.50	24.50
H23	8.75	8.11	7.02	11.10	24.70	22.67	21.02	18.18	28.77
H24	12.14	8.24	4.11	13.37	27.72	28.03	19.03	9.50	30.87
H25	11.13	8.06	4.06	10.74	27.37	26.03	18.85	9.50	25.10
H26	9.19	9.00	3.40	8.49	26.34	22.32	21.87	8.27	20.63
H27	11.49	8.35	3.56	11.18	28.51	25.78	18.75	8.00	25.10
H28	11.22	7.99	3.40	10.98	27.16	26.43	18.82	8.00	25.87
H29	9.30	7.94	3.12	9.68	24.19	24.60	21.02	8.27	25.60
H30	10.02	8.02	3.37	10.00	26.97	23.78	19.03	8.00	23.73
H31	8.29	7.56	3.21	8.40	25.68	20.67	18.85	8.00	20.93
H32	9.11	9.05	3.36	8.40	26.19	22.27	22.12	8.22	20.53
H33	8.79	8.66	7.58	9.65	27.22	20.67	20.37	17.82	22.70
I1	12.22	8.23	3.49	9.23	27.91	28.03	18.87	8.00	21.17
I2	11.54	8.58	3.77	9.92	29.22	25.28	18.78	8.27	21.73
I3	8.69	6.93	3.11	8.67	24.91	22.32	17.80	8.00	22.27
I4	9.36	7.43	3.12	8.68	24.97	24.00	19.03	8.00	22.23
I5	10.13	8.05	3.55	8.50	27.48	23.60	18.75	8.27	19.80
I6	9.00	8.66	3.22	8.02	25.76	22.37	21.50	8.00	19.93
I7	10.95	8.12	3.47	9.43	27.72	25.28	18.75	8.00	21.77
I8	10.03	7.35	3.21	9.23	24.99	25.68	18.84	8.22	23.63
J1	10.02	8.92	3.34	10.02	26.72	24.00	21.37	8.00	24.00
J2	9.66	8.15	3.38	9.51	26.20	23.60	19.92	8.27	23.23
J3	9.56	7.83	3.19	9.56	25.49	24.00	19.65	8.00	24.00
J4	9.75	8.28	3.25	9.75	26.00	24.00	20.38	8.00	24.00
J5	9.41	8.26	3.28	9.26	25.52	23.60	20.71	8.22	23.23
K1	11.49	9.26	5.27	11.51	26.24	28.03	22.60	12.87	28.07
K2	9.32	7.12	3.05	9.25	23.59	25.28	19.32	8.27	25.10
K3	8.93	7.11	3.20	8.25	25.60	22.32	17.78	8.00	20.63
K4	9.26	7.69	3.09	9.26	24.70	24.00	19.93	8.00	24.00
K5	10.04	7.90	4.47	10.05	23.82	26.98	21.22	12.00	27.00
L1	10.59	9.71	9.31	9.95	27.07	25.03	22.95	22.02	23.53
L2	8.43	8.71	3.37	8.58	26.11	20.67	21.35	8.27	21.03
L3	10.04	8.00	3.59	9.46	28.74	22.37	17.82	8.00	21.07
L4	9.77	8.62	11.20	9.20	27.95	22.37	19.73	25.65	21.07
L5	8.57	8.52	3.32	8.72	26.55	20.67	20.55	8.00	21.03
L6	10.41	8.27	3.25	10.44	26.04	25.58	20.33	8.00	25.67
L7	8.35	7.80	3.18	7.95	25.45	20.98	19.60	8.00	20.00
L8	9.27	7.13	2.98	9.44	23.84	24.88	19.13	8.00	25.33
L9	9.49	7.11	2.96	9.74	23.08	26.30	19.71	8.22	27.00
M1	11.03	8.95	3.15	11.05	25.19	28.03	22.75	8.00	28.07
M2	9.48	7.34	3.12	9.61	24.92	24.35	18.85	8.00	24.67
M3	12.43	8.08	3.52	12.75	28.17	28.23	18.35	8.00	28.97
M4	10.54	7.36	3.29	11.21	26.31	25.63	17.90	8.00	27.27
M5	9.27	7.54	3.09	9.27	24.73	24.00	19.50	8.00	24.00
M6	11.53	8.22	3.42	11.54	27.34	26.98	19.25	8.00	27.00
M7	10.77	8.45	3.28	10.78	25.55	26.98	21.18	8.22	27.00
N1	9.65	7.94	3.32	9.82	26.60	23.22	19.10	8.00	23.63
N2	9.67	7.51	3.28	9.52	26.22	23.60	18.33	8.00	23.23
N3	8.02	6.72	3.08	7.70	23.99	21.40	17.93	8.22	20.53
N4	8.89	7.89	3.12	9.15	24.92	22.83	20.27	8.00	23.50

N5	8.18	7.37	3.06	8.60	24.45	21.40	19.28	8.00	22.50
N6	7.88	6.81	3.14	8.34	24.46	20.62	17.83	8.22	21.83
N7	8.04	7.62	3.14	8.59	25.14	20.47	19.40	8.00	21.87
N8	9.05	8.81	3.38	8.69	27.07	21.40	20.82	8.00	20.53
N9	7.93	7.70	2.93	8.34	22.82	22.25	21.60	8.22	23.40
N10	10.71	8.13	3.63	10.54	29.04	23.60	17.92	8.00	23.23
N11	8.00	7.61	3.46	8.34	27.70	18.48	17.58	8.00	19.27
N12	9.61	8.76	3.52	9.74	27.43	22.43	20.43	8.22	22.73
N13	9.48	8.22	3.48	10.00	27.87	21.77	18.88	8.00	22.97
N14	9.04	7.70	3.17	9.28	25.39	22.78	19.40	8.00	23.40
N15	8.89	8.13	3.19	8.19	25.54	22.27	20.38	8.00	20.53
N16	10.54	8.55	3.39	9.77	26.43	25.52	20.70	8.22	23.67
O1	8.45	7.99	3.04	8.89	24.31	22.25	21.03	8.00	23.40
O2	10.25	8.46	3.47	10.09	27.79	23.60	19.48	8.00	23.23
O3	9.92	9.18	3.66	10.43	28.53	22.25	20.60	8.22	23.40
O4	8.92	6.80	3.02	8.78	24.19	23.60	18.00	8.00	23.23
O5	6.84	6.80	2.96	7.13	23.69	18.48	18.37	8.00	19.27
O6	9.97	7.55	3.23	9.99	25.84	24.68	18.70	8.00	24.73
O7	9.77	8.15	3.55	10.45	27.64	22.63	18.87	8.22	24.20
P1	11.84	8.61	3.38	9.88	27.04	28.03	20.38	8.00	23.40
P2	10.77	8.91	3.41	9.90	27.26	25.28	20.92	8.00	23.23
P3	9.35	8.21	3.44	8.07	26.81	22.32	19.58	8.22	19.27
P4	11.35	7.52	3.30	10.22	26.44	27.48	18.20	8.00	24.73
P5	11.20	7.98	3.20	9.35	25.56	28.03	19.98	8.00	23.40
P6	11.71	8.53	3.43	9.71	26.73	28.03	20.42	8.22	23.23
P7	11.86	8.44	3.39	8.15	27.09	28.03	19.93	8.00	19.27
P8	12.03	8.10	3.43	10.61	27.46	28.03	18.87	8.00	24.73
P9	10.53	8.00	3.22	10.44	25.06	26.90	20.42	8.22	26.67
P10	9.79	7.18	4.20	10.32	24.71	25.37	18.58	10.87	26.73
P11	9.56	7.54	5.02	9.87	23.05	26.53	20.93	13.95	27.40
P12	10.43	8.59	5.71	10.94	26.79	24.92	20.52	13.65	26.13
P13	10.51	7.40	3.32	9.72	26.58	25.30	17.82	8.00	23.40
P14	10.90	7.64	3.45	10.01	27.58	25.28	17.73	8.00	23.23
P15	9.82	9.28	3.39	8.16	27.10	23.20	21.92	8.00	19.27
P16	10.72	9.65	6.76	10.17	26.31	26.08	23.48	16.43	24.73
Q1	8.87	8.46	3.31	9.15	26.49	21.43	20.45	8.00	22.10
Q2	10.73	9.33	3.31	10.82	26.47	25.93	22.55	8.00	26.17
Q3	8.74	9.37	3.27	9.19	26.15	21.40	22.93	8.00	22.50
Q4	8.45	7.92	5.67	9.59	26.23	20.62	19.33	13.83	23.40
Q5	9.81	7.48	3.02	8.76	24.12	26.02	19.85	8.00	23.23
Q6	10.40	9.26	3.20	7.70	25.57	26.03	23.17	8.00	19.27
Q7	10.36	8.89	3.36	10.11	26.16	25.33	21.76	8.22	24.73
R1	8.68	8.50	4.34	8.17	24.62	22.57	22.10	11.28	21.23
R2	7.17	7.14	3.95	7.18	23.22	19.75	19.68	10.88	19.80
R3	8.01	7.96	7.41	8.22	25.84	19.83	19.70	18.35	20.37
R4	8.44	8.16	7.80	7.40	25.36	21.30	20.58	19.68	18.67
R5	8.65	8.62	6.04	8.79	27.99	19.78	19.72	13.82	20.10
S1	8.56	8.65	3.03	8.05	24.27	22.57	22.80	8.00	21.23
S2	7.81	7.30	3.17	7.83	25.32	19.75	18.45	8.00	19.80
S3	8.74	7.88	3.53	10.00	28.20	19.83	17.88	8.00	22.70
S4	9.34	8.29	5.91	8.79	26.49	22.57	20.03	14.27	21.23
S5	8.29	8.16	3.36	8.40	26.86	19.75	19.45	8.00	20.00
S6	7.31	7.50	2.95	7.50	23.58	19.83	20.37	8.00	20.37
S7	8.82	8.17	3.31	9.55	26.50	21.30	19.73	8.00	23.07
S8	9.11	7.22	5.58	10.51	25.83	22.58	17.88	13.83	26.03
S9	7.53	8.27	3.04	7.73	24.30	19.83	21.77	8.00	20.37
S10	8.30	7.78	3.12	7.27	24.93	21.30	19.98	8.00	18.67
S11	7.29	7.12	3.03	7.40	23.58	19.78	19.34	8.22	20.10
T1	8.24	8.41	2.92	7.75	23.37	22.57	23.03	8.00	21.23
T2	8.11	9.07	5.68	8.13	26.28	19.75	22.10	13.83	19.80
T3	8.49	8.63	3.01	7.99	24.08	22.57	22.95	8.00	21.23
T4	8.90	8.58	3.19	8.83	25.56	22.28	21.48	8.00	22.10
U1	10.32	8.99	3.23	9.24	25.19	26.22	22.83	8.22	23.47
U2	9.28	8.25	3.33	8.80	26.61	22.32	19.85	8.00	21.17
U3	9.30	8.27	2.91	7.72	23.26	25.58	22.75	8.00	21.23
U4	8.26	7.56	2.96	9.07	23.70	22.32	20.40	8.00	24.50
U5	8.42	6.92	2.82	7.35	22.58	23.87	19.60	8.00	20.83
U6	7.92	7.41	3.06	8.87	24.51	20.67	19.35	8.00	23.17
U7	10.56	8.96	3.43	9.71	26.74	25.28	21.45	8.22	23.23
U8	9.13	8.44	3.27	8.44	26.18	22.32	20.63	8.00	20.63

U9	9.31	9.12	3.34	8.49	26.71	22.32	21.85	8.00	20.33
U10	11.62	8.62	3.48	10.43	27.81	26.75	19.83	8.00	24.00
U11	9.24	7.75	3.15	8.87	25.19	23.47	19.70	8.00	22.53
U12	9.47	8.42	3.26	9.15	26.09	23.23	20.67	8.00	22.43
U13	10.44	8.03	3.25	8.32	25.97	25.73	19.78	8.00	20.50
U14	9.82	8.15	3.11	8.30	24.85	25.28	21.00	8.00	21.37
U15	9.65	8.88	5.12	8.92	27.67	22.32	20.53	11.85	20.63
U16	9.21	7.15	2.91	7.78	23.30	25.28	19.65	8.00	21.37
U17	10.61	8.50	3.36	9.14	26.44	25.68	20.58	8.13	22.13
U18	10.05	8.48	3.91	8.47	26.14	24.60	20.77	9.58	20.73
U19	8.37	6.85	3.49	8.35	22.52	23.78	19.47	9.93	23.73
U20	9.84	7.73	3.14	9.91	25.11	25.07	19.70	8.00	25.27
U21	9.23	7.42	3.26	8.79	26.05	22.67	18.23	8.00	21.60
V1	10.69	8.96	4.95	10.72	26.73	25.58	21.45	11.85	25.67
V2	8.25	8.21	2.96	7.63	23.67	22.32	22.20	8.00	20.63
V3	9.52	8.63	3.36	9.41	26.44	23.03	20.90	8.13	22.77
V4	7.86	7.48	4.51	8.00	24.34	20.67	19.67	11.85	21.03
V5	10.67	9.48	3.45	10.66	27.59	24.75	21.98	8.00	24.73
V6	8.15	7.82	4.45	7.51	23.83	21.90	21.00	11.95	20.17
V7	8.79	8.48	2.95	8.73	23.57	23.87	23.03	8.00	23.70
V8	8.18	8.54	3.28	8.30	25.84	20.25	21.15	8.13	20.57
V9	9.61	7.91	3.84	9.42	25.62	24.02	19.75	9.58	23.53
V10	8.44	9.06	4.07	8.00	26.20	20.62	22.12	9.93	19.53
V11	9.33	8.63	3.23	9.42	25.86	23.08	21.37	8.00	23.30
V12	7.69	8.99	3.18	8.07	25.45	19.33	22.62	8.00	20.30
V13	9.48	8.35	3.33	9.47	25.08	24.20	21.32	8.50	24.17
V14	8.09	8.15	4.89	8.08	26.29	19.70	19.85	11.90	19.67
V15	8.87	9.46	3.18	9.08	25.44	22.32	23.80	8.00	22.83
V16	8.76	9.41	3.66	8.66	28.83	19.45	20.88	8.13	19.23
V17	9.31	9.52	3.96	9.32	26.47	22.52	23.03	9.58	22.53
V18	8.61	9.55	4.42	9.04	28.49	19.33	21.45	9.93	20.30
V19	9.65	8.42	3.40	9.76	27.24	22.68	19.78	8.00	22.93
V20	8.00	8.57	5.73	7.72	25.34	20.20	21.65	14.48	19.50
V21	9.53	8.89	3.34	9.38	26.56	22.97	21.42	8.05	22.60
V22	7.82	8.88	3.14	8.07	24.69	20.27	23.02	8.13	20.93
V23	9.03	8.76	4.03	8.61	26.94	21.45	20.82	9.58	20.47
V24	7.52	6.65	3.33	7.43	21.45	22.45	19.85	9.93	22.17
V25	8.01	8.99	3.24	8.42	25.94	19.75	22.17	8.00	20.77
V26	9.85	8.22	4.86	10.04	26.13	24.12	20.13	11.90	24.60
V27	9.25	9.42	3.28	8.58	26.26	22.53	22.95	8.00	20.90
V28	8.95	9.58	3.65	9.43	28.70	19.97	21.37	8.13	21.03
V29	9.26	7.92	3.83	9.31	25.55	23.20	19.85	9.58	23.33
V30	8.78	8.67	3.86	8.44	24.85	22.62	22.33	9.93	21.73
V31	9.22	8.70	3.24	9.42	25.92	22.77	21.48	8.00	23.27
V32	8.58	8.54	3.09	8.67	24.73	22.22	22.12	8.00	22.43
V33	9.29	9.00	3.38	8.59	26.63	22.32	21.62	8.13	20.63
V34	10.25	8.80	4.51	10.13	27.60	23.77	20.40	10.45	23.50
V35	9.12	8.78	6.38	9.28	28.25	20.67	19.90	14.45	21.03
V36	9.74	9.49	3.32	9.73	25.84	24.12	23.50	8.22	24.10
V37	8.91	8.93	6.77	8.24	25.54	22.32	22.36	16.95	20.63
W1	7.98	8.28	8.28	8.25	23.05	22.17	22.98	23.00	22.90
W2	9.53	8.50	8.92	9.38	25.84	23.60	21.07	22.10	23.23
W3	7.50	6.69	7.79	7.92	21.66	22.17	19.75	23.00	23.40
W4	8.10	8.03	8.41	8.55	23.39	22.17	21.98	23.00	23.40
W5	8.81	7.78	8.25	8.48	23.88	23.60	20.85	22.10	22.73
W6	8.49	8.51	8.81	8.97	24.53	22.17	22.20	23.00	23.40
W7	10.25	9.62	4.30	9.88	27.81	23.60	22.15	9.90	22.73
W8	10.16	7.86	9.36	9.26	23.67	27.47	21.25	25.30	25.03
W9	10.70	9.02	4.22	10.31	29.02	23.60	19.88	9.30	22.73
W10	7.13	8.47	6.75	7.56	24.48	18.65	22.15	17.63	19.77
W11	10.11	8.63	10.05	9.90	26.13	24.77	21.14	24.60	24.23
X1	10.84	9.40	10.26	10.84	26.97	25.72	22.30	24.35	25.73
X2	9.82	8.16	8.60	9.20	26.93	23.33	19.38	20.43	21.87
X3	8.47	8.48	3.94	7.75	24.03	22.57	22.58	10.48	20.63
X4	10.78	8.83	4.05	10.61	27.07	25.50	20.88	9.58	25.10
X5	10.05	7.73	3.49	10.22	26.30	24.45	18.82	8.50	24.87
X6	8.58	8.65	3.36	8.13	25.35	21.65	21.83	8.48	20.53
X7	8.32	7.87	3.51	7.65	26.57	20.05	18.95	8.47	18.43

Table 6.2.2 Survey 2 Final Ranking

Part 2

In Part 2 the responders provided information for quantification of risk in shipping and shipboard activities by determining the Likelihood index and Severity index as discussed in Chapter 5. From the results for each ship type a set of variables determined for further analysis.

Below is presented the summary of these variables and analytically presented in Appendix 2.

RISK INDEX SUMMARY

	CAR	GEN	REF	BC	OT	CONT	GAS	CHEM
A1	4.67	5.20	5.33	4.90	5.58	3.60	5.25	5.75
A2	5.33	5.20	5.00	4.80	4.92	3.80	4.75	5.25
A3	5.67	5.20	5.50	5.65	5.42	5.00	5.75	4.75
A4	4.00	4.20	4.00	4.35	4.17	4.00	4.25	4.00
A5	2.33	2.40	3.33	2.90	3.58	2.80	3.50	3.75
A6	4.67	4.80	5.00	4.80	4.42	4.00	4.25	4.50
A7	3.00	2.20	3.33	2.70	2.50	2.60	2.75	2.25
A8	2.00	2.00	2.33	2.30	2.58	2.00	2.75	2.00
B1	3.00	2.60	3.17	2.95	2.92	2.60	3.50	2.00
B2	2.33	2.60	2.33	2.30	2.33	2.20	2.25	2.25
B3	4.00	3.60	4.17	4.00	4.75	3.40	4.75	4.25
B4	3.33	2.80	3.17	2.60	3.83	2.80	4.50	3.75
B5	3.33	3.00	3.33	3.05	3.83	3.80	4.50	3.75
B6	4.67	4.60	3.67	4.65	4.25	4.20	4.75	3.75
B7	2.67	2.20	2.50	2.60	2.58	2.60	2.75	2.25
B8	4.00	3.60	3.50	3.25	4.00	3.40	4.25	3.00
B9	3.33	2.40	3.17	2.90	3.75	3.00	4.75	3.75
B10	2.00	2.60	2.33	2.35	2.83	2.20	2.00	3.00
B11	3.67	4.20	4.50	4.15	4.00	4.20	3.50	4.75
B12	4.67	5.00	5.00	4.85	3.92	4.20	3.75	3.75
B13	2.67	2.80	2.67	3.10	3.58	2.40	3.75	3.50
C1	4.00	4.00	4.50	1.65	4.33	3.80	4.25	4.00
C2	2.67	2.40	2.67	1.30	3.58	2.40	3.75	3.50
C3	5.00	4.60	4.17	2.65	4.00	2.80	4.25	3.25
C4	3.00	3.80	3.17	2.10	3.42	2.80	3.25	2.50
C5	5.00	4.80	4.33	3.00	4.17	4.40	4.25	4.00
C6	4.00	3.40	4.50	2.15	4.08	4.20	5.00	4.25
C7	5.00	5.00	4.50	2.80	4.50	4.20	4.00	4.75
C8	2.00	2.00	2.00	1.00	2.00	2.00	2.00	2.00
D1	5.33	4.80	5.00	3.65	3.33	5.20	3.25	4.00
D2	4.67	4.80	4.33	1.50	4.67	4.20	4.75	4.50
D3	5.33	5.20	5.33	2.10	5.33	5.20	5.25	6.00
D4	5.33	4.80	5.33	3.05	5.08	4.20	4.25	5.25
D5	3.33	3.00	2.67	1.50	3.42	3.20	3.25	3.75
D6	5.00	4.80	4.67	3.85	3.75	3.40	4.00	3.75
D7	4.33	4.20	4.17	3.10	4.00	3.80	3.75	4.25
D8	4.00	3.20	3.67	1.50	3.50	3.80	3.75	3.50
D9	5.33	5.00	4.83	2.30	5.67	5.00	6.00	4.75
D10	3.67	3.80	3.33	1.60	3.67	3.60	3.75	3.25
D11	6.67	5.60	5.67	3.20	5.50	5.20	6.00	5.50
D12	6.33	6.80	5.33	2.10	5.33	4.80	5.25	5.25
D13	5.33	6.40	5.67	3.50	4.92	4.20	4.50	4.75
D14	6.33	6.00	5.50	3.40	4.42	4.60	5.00	4.25
E1	2.33	2.80	2.00	1.80	2.67	2.40	2.50	2.25
E2	5.33	5.60	4.83	3.55	3.33	3.20	3.50	3.50
E3	4.33	3.60	3.67	1.80	3.00	3.40	3.00	3.25
E4	5.33	5.00	4.17	1.60	4.08	4.20	4.25	4.25
E5	6.67	6.80	6.67	3.85	4.33	3.60	3.25	5.00
E6	4.33	3.60	4.67	2.00	4.17	4.60	5.00	4.00
E7	4.67	4.80	4.50	1.80	4.17	4.60	3.75	5.00
E8	4.00	3.80	3.83	1.90	3.75	4.00	4.00	4.00
F1	5.00	5.00	4.67	2.25	4.92	5.20	4.50	5.50
F2	4.67	5.00	5.00	2.50	5.25	5.20	4.75	5.75
F3	4.33	4.40	4.67	1.80	4.33	4.60	4.25	5.00
F4	2.00	2.00	2.00	1.10	2.17	2.20	2.25	2.25
F5	5.00	5.20	4.50	1.80	4.00	4.40	4.00	4.50

	CAR	GEN	REF	BC	OT	CONT	GAS	CHEM
F6	4.33	4.20	4.50	1.80	4.58	4.60	5.25	4.75
F7	3.00	3.80	3.33	1.60	3.42	3.60	3.50	3.00
F8	3.00	3.40	3.50	1.40	3.50	3.00	3.25	3.25
G1	3.00	2.80	3.33	1.70	3.25	3.40	3.25	3.50
G2	4.00	3.60	4.33	2.10	4.33	4.40	4.50	4.50
G3	4.00	3.40	4.67	2.30	4.25	4.40	4.75	3.75
G4	4.67	4.40	4.67	3.25	4.75	4.80	5.00	4.75
G5	4.00	4.20	4.00	3.25	4.17	4.00	4.00	4.25
G6	2.67	3.20	2.33	1.40	3.08	2.40	2.25	3.75
H1	4.33	5.60	4.17	2.45	4.92	4.60	4.50	5.00
H2	3.67	4.00	3.83	2.10	3.92	4.00	4.50	4.00
H3	4.00	4.00	4.00	2.00	3.67	4.00	4.00	4.25
H4	2.67	3.20	3.00	1.70	3.08	3.20	3.50	3.00
H5	5.33	4.80	5.17	2.70	5.08	5.00	5.50	5.00
H6	4.33	5.20	3.83	1.60	4.50	3.80	4.25	3.75
H7	3.00	2.20	3.00	1.40	3.08	3.40	3.75	3.25
H8	3.00	2.20	2.67	1.30	2.67	3.00	3.25	2.50
H9	4.67	4.00	4.50	2.10	4.50	4.40	4.50	4.25
H10	3.67	3.60	3.33	1.90	4.08	3.40	4.25	4.75
H11	2.67	3.60	3.00	1.50	3.08	2.80	2.75	2.75
H12	5.33	4.40	5.17	2.00	4.33	5.00	4.50	5.00
H13	4.33	3.80	4.17	2.10	4.08	4.20	4.50	3.75
H14	2.67	2.80	2.33	1.30	2.58	2.40	2.50	2.75
H15	3.33	2.80	3.33	1.50	2.83	3.20	3.00	3.50
H16	4.33	3.80	4.00	2.60	3.17	3.80	3.75	2.25
H17	3.67	4.40	3.33	2.00	3.58	3.40	3.25	4.00
H18	3.33	4.00	3.00	2.20	3.25	3.20	3.50	2.75
H19	4.00	3.60	4.00	2.20	3.67	4.00	4.00	4.00
H20	4.00	3.60	4.00	2.20	3.75	4.00	4.00	4.25
H21	3.33	4.40	3.50	2.30	4.33	3.80	4.00	4.75
H22	4.00	3.60	4.00	2.20	3.67	4.00	4.00	4.00
H23	5.00	5.40	5.00	3.15	5.33	5.00	5.50	5.50
H24	5.00	5.40	5.17	3.25	5.25	4.20	5.50	5.50
H25	3.67	4.20	3.50	2.30	4.67	3.80	4.75	4.50
H26	5.33	5.00	5.17	2.20	4.83	5.00	5.50	5.00
H27	3.67	3.80	3.50	2.20	3.75	3.80	3.75	3.50
H28	4.00	4.40	4.17	2.70	4.17	4.00	4.25	4.25
H29	3.67	3.40	3.50	1.90	3.17	3.40	3.25	3.25
H30	3.33	3.00	3.33	1.50	2.75	2.80	2.50	2.75
H31	3.67	4.20	3.33	2.00	3.42	3.40	3.25	3.75
H32	2.00	2.80	2.67	1.40	2.58	2.40	2.50	2.75
H33	4.67	5.00	5.00	2.30	5.00	4.80	4.75	5.25
I1	3.67	3.20	3.00	1.90	3.67	3.40	3.25	3.75
I2	2.67	3.60	3.00	1.90	3.42	2.80	3.00	4.25
I3	2.67	2.80	2.67	1.60	2.83	2.80	3.00	3.00
I4	2.67	3.20	3.00	1.90	3.00	2.40	3.00	3.00
I5	2.00	3.20	2.33	1.60	2.75	2.40	2.50	3.25
I6	4.00	3.80	4.00	2.20	3.92	3.60	4.25	4.25
I7	3.33	3.80	3.33	2.00	3.58	3.20	3.50	3.50
I8	3.67	3.40	3.67	2.00	3.25	3.40	3.25	3.50
J1	3.00	3.00	2.67	1.50	2.83	3.00	3.25	2.50
J2	3.67	3.80	3.17	1.50	3.08	3.00	3.25	3.25
J3	2.67	2.80	3.00	1.80	3.08	2.80	3.00	3.00
J4	2.33	2.80	2.67	1.30	2.75	2.20	2.75	3.00
J5	2.67	2.40	3.00	1.70	3.25	3.20	3.75	3.25
K1	4.00	3.80	4.33	2.00	3.92	4.00	4.00	4.25
K2	3.33	4.00	3.33	2.20	3.75	3.20	3.50	4.25
K3	4.00	3.80	3.83	1.90	3.58	3.60	3.75	3.25
K4	2.00	2.80	2.67	1.50	2.67	2.40	2.50	3.00
K5	4.00	4.40	4.17	2.30	4.25	4.00	3.50	4.25
L1	5.67	5.40	5.50	2.20	5.08	5.40	5.00	5.50
L2	3.00	3.80	2.83	1.70	2.92	2.20	2.75	3.00
L3	2.67	3.20	3.17	1.60	2.75	2.80	2.75	3.00
L4	5.00	5.20	5.00	1.90	4.58	5.00	4.25	5.00
L5	3.33	3.40	3.17	1.80	2.92	3.20	3.00	3.25
L6	2.67	3.20	3.33	1.60	3.42	3.60	3.50	3.75
L7	2.67	2.80	2.33	1.40	2.33	2.40	2.50	2.50

	CAR	GEN	REF	BC	OT	CONT	GAS	CHEM
L8	3.00	3.00	3.17	1.90	3.58	3.20	3.25	3.00
L9	3.67	3.60	3.67	1.80	3.67	3.40	4.00	3.75
M1	5.00	5.00	5.00	3.45	4.75	4.20	5.00	4.75
M2	4.67	4.80	5.00	3.15	4.83	4.60	4.75	4.75
M3	5.67	5.60	5.00	3.40	5.75	4.80	5.75	5.50
M4	5.33	5.60	5.17	3.35	5.67	5.00	5.50	5.00
M5	4.67	4.40	4.17	3.00	4.58	4.60	4.75	4.50
M6	4.67	4.80	4.67	3.35	4.67	3.60	5.00	5.00
M7	5.33	5.40	5.50	3.35	5.42	4.00	5.75	5.25
N1	2.67	3.20	3.00	2.00	3.33	3.00	2.75	3.25
N2	2.00	3.00	2.67	1.65	3.00	2.60	2.75	2.75
N3	2.67	2.80	3.00	1.80	3.08	3.00	3.25	3.50
N4	2.00	3.80	2.00	1.50	2.83	2.20	2.25	2.75
N5	3.33	4.00	3.50	2.40	3.67	3.40	3.25	4.00
N6	3.33	2.80	3.33	2.00	3.42	3.60	3.50	3.75
N7	2.00	2.40	2.33	1.40	2.67	2.40	2.50	2.50
N8	2.67	3.00	2.67	1.40	3.00	3.00	3.00	3.50
N9	2.67	3.60	3.17	1.80	3.17	3.00	2.50	3.50
N10	2.67	4.00	3.00	2.30	3.67	4.20	3.00	4.25
N11	2.00	3.40	2.83	1.70	3.00	2.40	2.50	3.25
N12	3.33	4.20	3.50	2.50	4.08	4.20	3.75	4.50
N13	2.67	3.60	3.00	2.20	3.25	2.80	3.25	3.00
N14	2.00	2.20	2.83	1.20	2.42	2.40	2.75	2.50
N15	3.33	3.00	3.33	1.80	3.33	3.60	4.00	3.50
N16	3.67	4.60	3.67	2.40	4.25	4.00	4.00	4.50
O1	3.33	4.00	3.67	2.80	3.83	3.60	3.50	4.00
O2	2.67	3.20	2.67	1.95	3.00	2.80	3.00	2.50
O3	3.33	2.40	3.00	1.50	2.42	2.80	2.50	2.75
O4	4.00	4.00	3.67	2.60	3.83	4.00	4.00	4.00
O5	2.00	2.80	2.67	1.50	2.67	2.40	2.50	2.50
O6	4.00	3.60	3.67	2.70	3.92	4.00	4.00	4.00
O7	3.33	3.60	4.00	2.60	4.17	3.80	4.25	3.50
P1	3.33	3.20	3.17	1.60	3.17	3.20	3.00	3.25
P2	2.67	3.60	3.33	1.50	3.25	3.20	3.00	3.50
P3	4.33	4.00	4.50	2.20	4.17	4.20	4.25	4.50
P4	4.00	4.20	4.17	2.00	4.17	4.00	4.00	4.00
P5	3.33	2.80	3.00	1.70	2.75	2.80	2.75	2.50
P6	3.00	3.00	2.67	1.40	2.83	3.00	2.75	3.25
P7	3.67	2.80	3.50	1.80	3.17	3.40	3.25	3.00
P8	5.00	5.00	5.17	2.10	4.83	5.40	4.75	4.75
P9	4.00	4.80	4.00	2.40	4.33	4.00	3.75	4.50
P10	5.00	4.00	4.50	2.40	4.33	4.80	4.75	4.00
P11	5.33	5.00	5.33	2.20	4.67	5.20	5.00	4.75
P12	4.00	2.80	3.00	1.50	2.92	3.60	3.50	2.75
P13	3.33	4.00	3.83	2.30	3.83	3.60	3.75	4.00
P14	3.67	3.40	3.17	1.80	3.33	3.40	3.25	3.50
P15	3.33	2.40	3.33	1.60	2.67	3.20	3.00	3.00
P16	5.33	5.20	5.50	3.35	5.42	5.20	5.50	5.50
Q1	3.67	3.40	3.17	2.10	3.58	3.60	3.50	4.00
Q2	2.33	3.80	2.50	1.70	3.25	2.80	3.00	3.25
Q3	3.33	2.80	3.00	1.60	2.50	2.80	2.50	2.50
Q4	4.00	4.00	4.00	2.30	4.17	4.00	4.25	4.25
Q5	3.33	4.60	3.83	1.90	4.17	3.40	3.50	4.50
Q6	2.67	2.40	2.67	1.40	2.83	2.80	2.50	3.00
Q7	4.00	4.20	4.33	2.70	4.17	3.80	4.00	4.75
R1	4.33	3.20	4.17	2.00	3.67	4.20	4.50	3.75
R2	3.00	2.60	2.83	1.60	3.17	3.20	2.75	3.75
R3	4.00	5.20	4.00	2.00	4.25	4.00	3.50	4.25
R4	5.33	4.00	5.50	1.80	4.75	5.60	5.50	5.00
R5	3.33	3.20	2.67	1.70	3.08	3.00	3.50	2.25
S1	2.67	3.20	3.33	1.80	3.00	3.20	3.00	3.50
S2	2.67	2.00	3.00	1.70	2.67	2.80	3.00	2.50
S3	2.67	3.60	2.33	2.00	2.83	2.80	2.50	2.50
S4	3.33	3.20	3.67	1.60	3.33	3.60	3.75	3.25
S5	3.33	2.40	3.33	1.90	2.83	3.20	3.00	3.00
S6	2.67	3.60	2.33	1.90	2.83	2.40	2.50	2.50
S7	4.00	2.40	4.00	1.80	3.33	4.00	4.00	3.50

	CAR	GEN	REF	BC	OT	CONT	GAS	CHEM
S8	4.00	3.60	3.67	2.40	4.33	4.40	4.75	4.25
S9	2.67	3.60	2.33	1.90	2.83	2.40	2.50	2.50
S10	4.00	2.80	4.00	2.10	3.33	4.00	4.00	3.50
S11	2.67	3.20	2.33	1.90	2.75	2.40	2.50	2.75
T1	3.33	2.80	2.67	1.40	2.50	2.80	3.00	2.00
T2	4.00	2.80	4.00	2.00	3.83	4.40	4.25	4.25
T3	4.00	3.60	3.67	2.20	3.67	4.00	4.00	4.00
T4	3.33	3.20	3.67	2.70	3.67	3.60	3.50	4.00
U1	3.67	4.80	4.00	1.70	4.08	3.60	3.75	4.25
U2	3.33	3.40	3.50	1.70	3.33	3.40	3.50	3.00
U3	3.67	4.00	3.50	1.90	3.58	3.80	3.75	3.75
U4	3.33	3.20	3.50	2.00	3.17	3.20	3.75	3.00
U5	4.67	4.40	4.50	2.70	4.42	4.60	4.75	4.50
U6	3.33	4.40	3.00	1.80	3.58	3.40	3.00	3.75
U7	3.33	4.40	3.67	2.30	3.83	3.60	3.75	4.25
U8	3.67	4.20	4.00	2.00	4.00	4.00	3.75	4.50
U9	2.67	3.40	3.33	2.00	3.58	3.20	3.75	3.75
U10	3.67	4.00	4.00	2.50	4.00	3.80	4.25	3.50
U11	3.33	4.40	3.50	2.60	3.83	3.40	3.25	3.75
U12	4.00	3.80	4.17	2.70	4.50	4.20	4.75	4.00
U13	4.00	3.60	4.17	2.30	4.08	4.00	4.50	3.50
U14	4.33	5.20	4.33	2.20	4.83	4.60	4.75	5.00
U15	4.33	4.00	4.33	2.20	4.00	4.40	4.25	4.25
U16	3.00	3.20	2.83	2.00	3.25	3.00	3.25	3.25
U17	2.67	4.00	3.33	2.10	3.67	3.20	3.00	4.00
U18	4.33	3.20	4.17	2.20	3.58	4.40	4.25	3.50
U19	2.00	3.40	2.33	1.70	2.75	2.00	2.00	2.75
U20	3.00	3.40	3.50	1.60	3.42	3.40	4.00	3.25
U21	2.67	3.20	2.67	1.40	2.83	2.80	2.50	3.00
V1	3.67	4.00	3.67	2.00	3.67	4.00	3.75	4.25
V2	3.33	2.40	3.67	2.00	3.17	2.80	4.00	3.00
V3	2.67	2.40	3.00	1.90	3.08	3.20	3.50	3.00
V4	3.67	4.40	3.33	2.10	3.50	3.20	3.25	3.75
V5	3.33	3.20	3.67	2.30	3.50	3.80	3.50	3.50
V6	3.00	2.40	3.33	1.60	3.08	3.40	3.25	3.00
V7	3.33	3.60	3.33	1.80	3.50	3.60	3.50	4.00
V8	3.33	3.60	3.00	2.10	3.08	3.20	3.00	3.00
V9	3.00	3.60	3.17	2.00	3.42	3.60	3.25	4.00
V10	3.33	3.00	3.67	2.00	3.58	3.60	4.00	3.25
V11	2.67	2.80	2.67	1.50	2.33	2.40	2.00	2.50
V12	2.67	3.20	2.67	1.80	2.83	2.80	3.00	2.50
V13	3.00	3.80	3.17	2.00	3.08	3.00	2.50	3.25
V14	3.00	3.60	3.33	2.10	3.42	3.40	3.25	3.50
V15	2.67	3.20	3.00	2.10	3.33	3.20	3.50	3.50
V16	2.67	2.80	2.67	1.80	2.58	2.40	2.50	2.00
V17	3.67	3.60	3.83	2.50	3.58	4.00	3.75	4.00
V18	2.67	3.40	2.67	1.80	3.08	2.80	3.00	2.75
V19	3.33	4.00	3.00	2.10	3.33	3.20	3.00	3.50
V20	3.33	3.60	3.67	2.00	3.75	3.80	4.25	3.25
V21	2.67	3.60	3.00	2.10	3.42	3.60	3.50	3.75
V22	2.67	3.60	2.67	2.30	3.25	2.80	2.50	3.50
V23	2.33	2.00	2.17	1.00	2.08	2.40	2.25	2.00
V24	2.67	2.60	2.67	1.60	2.92	2.80	3.00	2.75
V25	2.67	2.80	2.67	1.60	2.83	3.00	3.00	3.00
V26	3.00	3.20	3.00	1.70	3.25	3.40	3.25	3.00
V27	4.00	3.20	3.67	2.30	3.17	3.60	3.50	3.00
V28	2.67	3.60	2.67	2.00	3.08	3.00	3.00	3.00
V29	3.67	3.20	3.17	2.10	3.25	3.40	3.75	2.50
V30	4.00	3.40	4.00	2.30	3.75	3.80	4.00	4.25
V31	3.33	3.60	3.33	2.50	3.83	3.80	4.00	3.50
V32	2.67	3.60	3.00	1.90	3.50	2.80	3.50	3.50
V33	4.00	3.60	4.00	2.20	3.75	3.60	4.00	4.00
V34	4.33	4.20	4.33	2.70	3.92	4.00	4.25	4.00
V35	3.67	4.40	3.50	2.00	3.58	3.80	3.00	4.25
V36	4.00	4.00	3.67	2.40	3.92	3.60	4.00	4.25
V37	5.33	4.40	5.17	2.00	4.42	4.80	4.75	4.50
W1	4.00	4.60	4.33	2.50	4.50	4.40	4.25	4.75

	CAR	GEN	REF	BC	OT	CONT	GAS	CHEM
W2	4.00	4.00	4.00	2.60	4.17	4.40	4.25	4.50
W3	4.33	4.40	4.33	2.80	4.50	4.60	4.00	4.50
W4	3.67	4.40	4.33	2.80	4.00	4.20	3.50	4.50
W5	6.00	6.00	5.50	2.60	5.67	6.00	5.75	6.00
W6	3.67	4.40	4.33	2.80	4.17	4.20	3.50	4.75
W7	2.67	2.40	2.67	1.60	3.00	2.80	3.25	2.50
W8	4.67	5.40	5.00	2.60	5.08	4.80	4.50	5.50
W9	2.00	3.20	2.83	1.80	3.08	2.80	3.00	3.50
W10	3.00	4.20	4.00	1.70	4.33	3.80	4.25	4.50
W11	6.00	6.00	5.67	2.80	5.92	6.00	5.75	6.00
X1	3.67	4.00	3.67	2.10	3.75	4.60	3.75	3.75
X2	3.00	3.60	3.17	1.80	3.50	3.40	3.75	3.50
X3	4.33	3.40	4.17	2.10	3.67	4.20	4.50	3.50
X4	3.67	4.20	4.00	2.80	4.00	4.40	3.75	4.25
X5	5.33	5.20	4.50	2.50	5.25	5.20	5.75	5.25
X6	2.00	2.00	2.33	1.10	2.42	2.40	2.50	2.75
X7	2.67	2.60	2.67	1.30	2.67	2.80	3.00	2.50

Table 6.2.3 Survey 2 Risk Index Summary

A multivariable correlation analysis examines the relationship among the cause's possibility and the exposure confidence for the probability of an incident with ship's type risk index for the specific shipping and shipboard activities. These variables analyzed relationship between the variables and further could be used for the prediction of the risk level under certain condition of activities. A combined table is presented below with all variables as independent and depended variables. For the analysis the independed variables causes categories tested with each of the depended variables BC,CC,OT,GC,CON,GC,CH,REF. Particularly its considered the determination of an expression for the prediction of risk level by the values of the probable incident per management system.

For Bulk Carriers the following results produced by the form of:

$$Y=\text{coef(intercept)}+\text{coef(SAF SRI)}X_1+\text{coef(QTY SRI)}X_2+\text{coef(ENV SRI)}X_3+\text{coef(OHS SRI)}X_4$$

The statistical software tool MS Excel Tool pack Analyze it was used to conduct the multi variable correlation tests. The independent variables are tested in the multivariable analysis are IASMAR scores based on possibility of an incident by causes categories and the confidence for the exposure by the particular cause. The depending variables are the predicting success risk index. The correlation coefficient R Square between the cause's possibility for exposure and success risk index in predicting risk level presented below for each ship's type and full analysis presented in the Appendix 2. The results prove that the objectives of the research are met and the conditions and objectives have been fulfilled.

1. GENERAL CARGO

Regression Statistics					
Multiple R	0.670036				
R Square	0.448948				
Adjusted R Square	0.439349				
Standard Error	0.840491				
Observations	274				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance*
Regression	4	53.88982	13.47246	19.07129	8.02E-14
Residual	269	190.0286	0.706426		
Total	273	243.9184			

Table 6.2.4 Survey 2 Risk Index General Cargo

2. CONTAINER

Regression Statistics					
Multiple R	0.646194				
R Square	0.417567				
Adjusted R Square	0.407894				
Standard Error	0.691945				
Observations	274				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	54.75898	13.68975	28.59252	8.3E-20
Residual	269	128.7939	0.478788		
Total	273	183.5528			

Table 6.2.5 Survey 2 Risk Index Container

3. BULK CARRIER

Regression Statistics					
Multiple R	0.793556				
R Square	0.629731				
Adjusted R Square	0.612319				
Standard Error	0.66537				
Observations	274				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	21.8261	5.456525	12.32508	3.23E-09
Residual	269	119.091	0.442717		
Total	273	140.9171			

Table 6.2.6 Survey 2 Risk Index Bulk Carrier

4. REEFER

Regression Statistics					
Multiple R	0.737525				
R Square	0.544933				
Adjusted R Square	0.538359				
Standard Error	0.758232				
Observations	274				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	62.84099	15.71025	27.32614	4.81E-19
Residual	269	154.6525	0.574916		
Total	273	217.4935			

Table 6.2.7 Survey 2 Risk Index Reefer

5. GAS CARRIER

Regression Statistics					
Multiple R	0.850779				
R Square	0.723826				
Adjusted R Square	0.710006				
Standard Error	0.825876				
Observations	274				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	25.74375	6.435938	9.435879	3.76E-07
Residual	269	183.4771	0.682071		
Total	273	209.2208			

Table 6.2.8 Survey 2 Risk Index Gas Carrier

6. CHEMICAL CARRIER

Regression Statistics					
Multiple R	0.78575				
R Square	0.617403				
Adjusted R Square	0.604592				
Standard Error	0.782928				
Observations	274				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	50.92159	12.7304	20.76816	6.23E-15
Residual	269	164.8907	0.612977		
Total	273	215.8123			

Table 6.2.9 Survey 2 Risk Index Chemical Carriers

7. OIL TANKER

Regression Statistics					
Multiple R	0.841501				
R Square	0.708124				
Adjusted R Square	0.682952				
Standard Error	0.721692				
Observations	274				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	33.9221	8.480526	16.28241	5.89E-12
Residual	269	140.1059	0.52084		
Total	273	174.028			

Table 6.2.10 Survey 2 Risk Index Oil Tankers

8. CAR CARRIER

Regression Statistics					
Multiple R	0.711583				
R Square	0.506352				
Adjusted R Square	0.490739				
Standard Error	0.860788				
Observations	274				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	70.65688	17.66422	23.83977	6.83E-17
Residual	269	199.3172	0.740956		
Total	273	269.974			

Table 6.2.11 Survey 2 Risk Index Car Carriers

To further investigate the relationship between success risks score for management system cause probability of related incident and RI a multi non linear regression analysis was contacted using MS tool pack and summary results presented above.

As can be seen in the above tables the correlation R square between the determined cause possibility and exposure the IASMAR RSI and risk index RI can be described as a moderate positive relationship between the variables. That is, as the independent variables score increases which means the possibility of cause and exposure of an incident per management system increases the risk index increases and the activity should be prioritized by the relative score.

	GC	CON	BC	REF	GAS	CHE	OIL	CAR
R	0.67	0.64	0.79	0.73	0.85	0.78	0.84	0.71
R Sq	0.45	0.41	0.62	0.54	0.72	0.61	0.70	0.50

Table 6.2.12 Survey 2 Summary R and R square

The R square value for each type of ship are significantly different than zero, each value represents that a linear relationship with IASMAR SRI explains about 40-70 respectively percent of the sample variance of the risk index which proves the relationship of the variables. Scatter plots along with residual plots and predicted risk scores for all type of ships shown in figures above for safety, quality, environmental and occupational health management systems. Practically this approach provides a quality ingredient in the risk score which is simply a number and cannot interpret the assessment of quality characteristics of the current assessment conditions. If we consider that an activity should happened Remote (3) with severity Severe (3) means RI=6 which is Moderate risk level and limited risk control options should apply. But even is considered 1 incident per 1000 ships with 1 fatality or multiple injures this could be happened in the next particular activity. But if we analyze the possibility of cause category in present conditions unsafe conditions (i.e. piracy in UK) which is practically impossible and confidence of risk exposure very low or not at all then the safety IASMAR score is leading risk index for this particular case to trivial by adjusting frequency to minimum and not the severity which remains unchanged.

Conclusions of Survey 2

The Survey 2 is considered a survey of meeting objectives and conditions of the IASMAR project. In the first part for the set of probable uncertain conditions of management systems for safety, quality, environmental and occupational health analyzed to obtain the possibility of cause category affecting the incident and the confidence for the exposure in liabilities and consequences determined to provide qualitative characteristics the calculated risk index. In the inventory of shipping and shipboard activities a generic assessment made and a number of methods were used to collect process and analyze data. The purpose of the survey was to produce data and statistical analysis for the inventory of activities identified which granted permission to participants to reach tentative conclusions for risk assessment of activities as is as well as to challenge the estimation of possible cause and liability confidence so as to produce a similar quantifiable result in a different way. The first condition fulfilled since the IASMAR ranking score indicates the current level of risk index and corresponds to risk performance by prioritizing control measures and allocating properly the resources. The second condition also fulfilled since IASMAR score is a reliable indicator and could be used to quantify properly the actual and potential risk factors. The research aims and objective also fulfilled since a methodology and a database for risk management of activities have been determined including action research, ranking of shipping and shipboard activities carried out, an IASMAR benchmarking for success risk index placed and data analysis in the form of regression modeling and statistical test for effective explanation of sample carried out. It was proved also by case studies that results produced are unique in maritime risk management planning and provide a basis for effective and reliable risk analysis and management for maritime industries.

It is also provides a systematic risk management approach for the assessment and management of maritime activities within the process of the four risk management elements. There were identified during the survey that there are a lot already good and professional management companies, which have taken seriously into consideration the risk management process, trying to establish, and link risk management to the implemented management system and some of these, succeeded already to implement on day-to-day operations. It is also very important that it validate the IASMAR as an effective and reliable tool for prediction of risk level in relationship with safety, quality, and environmental and occupational health incidents probability. In the survey, responders were asked to provide information about the level of these characteristics and by those knowledge outcomes a set of case studies and areas of research auditing determined. It has also provided responses to a potential new implemented or amended safety management system and made evaluation of them. It has also enhanced communication with participants representing a reliable sample through whom a risk based management and decision making investigated and developed based in the existing quality, safety, environmental and occupational health management systems. It has also enhanced responsibility for self and others by replying critical questions related to level of risk to life, property, environment and reputation in each ship's type by utilizing the experienced incidents. Table below summarizes the main conclusions and achievements in the Survey 2 and relative information from the appendices.

Sectional achievements from Survey 2

The Part 1 and 2 sets the probability of an incident related to safety, quality, and environmental and occupational health implemented management system by cause category and participants estimates for confidence of the exposure or liabilities for that. Data collected from the sample proved adequate and reliable. Several analysis techniques were used to evaluate results from 40 case studies in 8 different types of ships. Bivariate Correlation, Non Linear multivariable Regression were all used in analyzing the data. The probability of an incident by cause category in combination with the confidence in exposure and the risk index by combination of likelihood and severity indices were collected from the survey and used to develop a success risk index for each type of ship. The regression analysis also revealed correlations between management systems probability incidents with success risk index for all 8 types of ships. The purpose of this survey 2 is to develop a decision support model for maritime risk managers to use in efficiently manner assessing the possible cause and relative exposure in probability of having an incident and the potential risk level to the shipping and shipboard activity. These models can be used by ship managers as a maritime risk management tool to maintain a high probability of success during the planning phase of the activities for additional control measures and proper assignment of resources. Activities create a dynamic list providing different outcomes. Furthermore, the models can be used by ship managers in implementing risk management to efficiently assess and adjust risk exposures that have the greatest impact on management success.

The Survey 2 fulfils the aims and objectives by:

- Establishment of a risk based auditing system collecting data in a systematic way for the estimation and assessment of incident probability pertinent to the SQEOH management system.
- Establishing a detailed inventory of shipping and shipboard activities as a dynamic list for assessment and evaluation of impact emanated from associated hazards, and a methodology for assessment level of risk, likelihood of occurrence and severity of impacts and finally to determine the correlation between these variances.
- Provide a systematic list and further validate the IASMAR project through testing by measuring the success of predicting risk index under certain values of management system variables.
- Developed my company's and own professional capacity by demonstrating risk proactive management and skills and contribute systematic and self explanatory knowledge and skills to participants and interested parties in maritime industry.
- Promote research success by testing the conditions and found correlation among independent SQEOH incident probability and IASMAR risk index score.

Finally the results of five variables multivariable regression demonstrated a significant correlation and supported the first and second research condition, the R square value also for each type of ship are significantly high which represents that the relationship with IASMAR risk index score explain about 40-70 respectively percent of the sample variance of the risk index success which proves the strong correlation of management system variables.

6.3 Survey 3

General Characteristics

The Survey 3 derived also in two parts 1 and 2. The completed responses I received finally were 15 replies for the first part which were used for data evaluation and analysis. In the second part 4 companies participated and relative responses collected which considered adequate for the level and extend of the survey. It was considered that all core elements are not equally important with respect to the potential impact on the risk performance of the implemented management system and each element needed to be weighted relative to others since higher weights assigned to those core elements whose contribution to risk level definition is significant providing risk management performance results.
The weighting of each core element is used to determine a total risk ranking score for verification through an auditing system implementation. The critical core elements also evaluated by the participants for risk contribution according to 4 basic criteria already assigned in previous chapter. The results tested and found strongly correlated proving that criteria for risk ranking are correctively set for interpretation of qualitative characteristics for risk based SQEOH management core elements. The projected predicted risk values emanated by the regression analysis should considered risk index benchmark and should widely used in industry and could be an effective scale of risk definition and performance. The verification is effected in part 2 as by relative auditing, scoring weighting and comparison with benchmark areas for further improvement identified for risk management.

Part 1

As noted in Chapter 5 in the first Part 1 the responders asked to rank by specific weight each of the 20 core elements by using the method of relative importance. Ranking score for **SAFETY** from collected data presented in the below table.

Point	Column1	Rank	Percent
20	17.933	1	100.00%
16	16.667	2	94.70%
4	15.467	3	89.40%
8	14.800	4	84.20%
1	14.467	5	78.90%
19	14.267	6	73.60%
10	14.133	7	68.40%
18	13.800	8	63.10%
7	13.667	9	57.80%
6	12.067	10	52.60%
11	10.933	11	47.30%
3	9.333	12	42.10%
9	8.800	13	36.80%
13	7.800	14	31.50%
12	7.533	15	26.30%
14	7.133	16	21.00%
15	4.400	17	15.70%
17	3.133	18	10.50%
5	2.267	19	5.20%
2	1.400	20	0.00%

Table 6.3.1 Survey 3Part 1 Core elements ranking per Safety

Rank	SAFETY RANKING	Total weights	Scaled weights
1	LEADERSHIP AND MANAGEMENT	1485	1
2	PERSONNEL RECRUITMENT AND TRAINING	1395	0.93939
3	RISK PREPAREDNESS AND PLANNING	1255	0.84512
4	ACCIDENT INVESTIGATION AND ANALYSIS	945	0.63636
5	RISK MANAGEMENT AND EVALUATION	595	0.40067
6	PLANNED MAINTENANCE	535	0.36027
7	RISK ASSESSMENT AND ESTIMATION	530	0.3569
8	MANAGEMENT OF CHANGE	515	0.3468
9	STAKEHOLDERS AND COMMUNICATION	475	0.31987
10	RISK AND CRITICAL TASK ANALYSIS	445	0.29966
11	OPERATION AND NAVIGATION	395	0.26599
12	NATURE AND SCOPE OF DECISION	385	0.25926
13	HAZARD IDENTIFICATION	330	0.22222
14	MATERIALS AND SERVICE MANAGEMENT	325	0.21886
15	PERFORMANCE STANDARDS	305	0.20539
16	RISK SCENARIOS	295	0.19865
17	RISK SELF ASSESSMENT & AUDITING	290	0.19529
18	PURCHASING AND SUBCONTRACTING CONTROL	275	0.18519
19	CARGO, BALLAST AND MOORING	240	0.16162
20	MEASUREMENT ANALYSIS AND IMPROVEMENT	220	0.14815

Table 6.3.2 Survey 3Part 1 Core elements Safety ranking

From the table above participant's collected data analyzed for the prioritization of the core elements as per safety and the specific weight by which each one contributes to the assessment and evaluation of the collected data. Ranking score for **QUALITY** from collected data presented in the below table.

Q	*Column1*	*Rank*	*Percent*
18	17.47	1	100.00%
11	16.27	2	94.70%
12	15.80	3	89.40%
17	15.73	4	84.20%
20	15.40	5	78.90%
16	14.73	6	73.60%
15	14.53	7	68.40%
14	13.13	8	63.10%
10	12.20	9	57.80%
13	11.47	10	52.60%
8	9.53	11	47.30%
7	9.47	12	42.10%
9	8.87	13	36.80%
19	8.73	14	31.50%
6	8.33	15	26.30%
5	6.80	16	21.00%
4	5.00	17	15.70%
3	3.27	18	10.50%
2	1.80	19	5.20%
1	1.47	20	0.00%

QUALITY

Rank	QUALITY RANKING	Total weights	Scaled weights
1	LEADERSHIP AND MANAGEMENT	1365.00	1.00000
2	PERSONNEL RECRUITMENT AND TRAINING	1335.00	0.97802
3	RISK PREPAREDNESS AND PLANNING	925.00	0.67766
4	ACCIDENT INVESTIGATION AND ANALYSIS	745.00	0.54579
5	RISK MANAGEMENT AND EVALUATION	615.00	0.45055
6	PLANNED MAINTENANCE	595.00	0.43590
7	PURCHASING AND SUBCONTRACTING CONTROL	575.00	0.42125
8	STAKEHOLDERS AND COMMUNICATION	565.00	0.41392
9	RISK ASSESSMENT AND ESTIMATION	535.00	0.39194
10	MANAGEMENT OF CHANGE	520.00	0.38095
11	MATERIALS AND SERVICE MANAGEMENT	495.00	0.36264
12	RISK AND CRITICAL TASK ANALYSIS	475.00	0.34799
13	PERFORMANCE STANDARDS	460.00	0.33700
14	RISK SELF ASSESSMENT & AUDITING	420.00	0.30769
15	NATURE AND SCOPE OF DECISION	375.00	0.27473
16	MEASUREMENT ANALYSIS AND IMPROVEMENT	335.00	0.24542
17	CARGO, BALLAST AND MOORING	295.00	0.21612
18	HAZARD IDENTIFICATION	265.00	0.19414
19	OPERATION AND NAVIGATION	225.00	0.16484
20	RISK SCENARIOS	220.00	0.16117

Table 6.3.3 Survey 3Part 1 Core elements Quality ranking

From the table above participant's collected data analyzed for the prioritization of the core elements *as per quality* and the specific weight by which each one contributes to the assessment and evaluation of the collected data.
Ranking score for **ENVIRONMENTAL** from participants' collected data presented in the below table.

Point	*Column1*	*Rank*	*Percent*
19	18.40	1	100.00%
20	17.27	2	94.70%
18	16.60	3	89.40%
17	16.07	4	84.20%
13	15.60	5	78.90%
14	14.53	6	73.60%
16	14.40	7	68.40%
11	14.07	8	63.10%
15	12.73	9	57.80%
10	10.27	10	52.60%
8	10.07	11	47.30%
9	9.73	12	42.10%
12	8.87	13	36.80%
6	8.20	14	31.50%
7	6.07	15	26.30%
5	6.00	16	21.00%
4	4.60	17	15.70%
3	2.87	18	10.50%
2	2.33	19	5.20%
1	1.33	20	0.00%

Rank	ENVIRONMENTAL RANKING	Total weights	Scaled weights
1	LEADERSHIP AND MANAGEMENT	1405.00	1.00000
2	PERSONNEL RECRUITMENT AND TRAINING	1135.00	0.80783
3	RISK PREPAREDNESS AND PLANNING	1040.00	0.74021
4	ACCIDENT INVESTIGATION AND ANALYSIS	815.00	0.58007
5	RISK MANAGEMENT AND EVALUATION	690.00	0.49110
6	RISK ASSESSMENT AND ESTIMATION	645.00	0.45907
7	PLANNED MAINTENANCE	535.00	0.38078
8	HAZARD IDENTIFICATION	510.00	0.36299
9	STAKEHOLDERS AND COMMUNICATION	505.00	0.35943
10	MANAGEMENT OF CHANGE	485.00	0.34520
11	RISK AND CRITICAL TASK ANALYSIS	455.00	0.32384
12	RISK SELF ASSESSMENT & AUDITING	425.00	0.30249
13	OPERATION AND NAVIGATION	405.00	0.28826
14	NATURE AND SCOPE OF DECISION	395.00	0.28114
15	PERFORMANCE STANDARDS	355.00	0.25267
16	MATERIALS AND SERVICE MANAGEMENT	340.00	0.24199
17	CARGO, BALLAST AND MOORING	285.00	0.20285
18	RISK SCENARIOS	255.00	0.18149
19	MEASUREMENT ANALYSIS AND IMPROVEMENT	235.00	0.16726
20	PURCHASING AND SUBCONTRACTING CONTROL	220.00	0.15658

Table 6.3.4 Survey 3Part 1 Core element Environmental ranking

From the table above participant's collected data analyzed for the prioritization of the core elements *as per environmental* and the specific weight by which each one contributes to the assessment and evaluation of the collected data. Ranking score for Occupational Health and Safety from participants' collected data presented in the below table.

Point	*Column1*	*Rank*	*Percent*
20	18.13	1	100.00%
19	17.53	2	94.70%
16	16.53	3	89.40%
17	16.47	4	84.20%
18	15.40	5	78.90%
13	15.27	6	73.60%
14	14.40	7	68.40%
15	14.20	8	63.10%
12	12.80	9	57.80%
11	10.47	10	52.60%
9	9.53	11	47.30%
8	9.33	12	36.80%
10	9.33	12	36.80%
7	8.00	14	31.50%
5	6.00	15	26.30%
6	5.47	16	21.00%
4	5.07	17	15.70%
2	2.47	18	10.50%
3	2.13	19	5.20%
1	1.47	20	0.00%

Rank	OHSAS RANKING	Total weights	Scaled weights
1	LEADERSHIP AND MANAGEMENT	1355.00	1.00000
2	RISK PREPAREDNESS AND PLANNING	1205.00	0.88930
3	PERSONNEL RECRUITMENT AND TRAINING	1090.00	0.80443
4	ACCIDENT INVESTIGATION AND ANALYSIS	740.00	0.54613
5	RISK ASSESSMENT AND ESTIMATION	690.00	0.50923
6	RISK MANAGEMENT AND EVALUATION	685.00	0.50554
7	PLANNED MAINTENANCE	505.00	0.37269
8	HAZARD IDENTIFICATION	495.00	0.36531
9	MANAGEMENT OF CHANGE	470.00	0.34686
10	STAKEHOLDERS AND COMMUNICATION	435.00	0.32103
11	RISK AND CRITICAL TASK ANALYSIS	415.00	0.30627
12	RISK SELF ASSESSMENT & AUDITING	390.00	0.28782
13	PERFORMANCE STANDARDS	375.00	0.27675
14	NATURE AND SCOPE OF DECISION	345.00	0.25461
15	OPERATION AND NAVIGATION	330.00	0.24354
16	RISK SCENARIOS	315.00	0.23247
17	CARGO, BALLAST AND MOORING	275.00	0.20295
18	MATERIALS AND SERVICE MANAGEMENT	260.00	0.19188
19	MEASUREMENT ANALYSIS AND IMPROVEMENT	225.00	0.16605
20	PURCHASING AND SUBCONTRACTING CONTROL	225.00	0.16605

Table 6.3.5 Survey 3Part 1 Core element OH ranking

The total weights collected presented below and represent the full weight produced for each core element. By dividing each element by the total weight a data of scaled weight produced for the contribution of each element to the final analysis.

	CORE ELEMENTS		TOTAL WEIGHT		
		SAFETY	QUALITY	ENVIRON	OHSAS
1.	NATURE AND SCOPE OF DECISION	385	375	395	345
2.	LEADERSHIP AND MANAGEMENT	1485	1365	1405	1355
3.	STAKEHOLDERS AND COMMUNICATION	475	565	505	435
4.	RISK SCENARIOS	295	220	255	315
5.	PERSONNEL RECRUITMENT AND TRAINING	1395	1335	1135	1090
6.	OPERATION AND NAVIGATION	395	225	405	330
7.	HAZARD IDENTIFICATION	330	265	510	495
8.	CARGO, BALLAST AND MOORING	240	295	285	275
9.	MANAGEMENT OF CHANGE	515	520	485	470
10.	PERFORMANCE STANDARDS	305	460	355	375
11.	RISK AND CRITICAL TASK ANALYSIS	445	475	455	415
12..	PLANNED MAINTENANCE	535	595	535	505
13.	RISK ASSESSMENT AND ESTIMATION	530	535	645	690
14.	RISK MANAGEMENT AND EVALUATION	595	615	690	685
15.	ACCIDENT INVESTIGATION AND ANALYSIS	945	745	815	740
16.	PURCHASING AND SUBCONTRACTING CONTROL	275	575	220	225
17.	RISK PREPAREDNESS AND PLANNING	1255	925	1040	1205
18.	MATERIALS AND SERVICE MANAGEMENT	325	495	340	260
19.	RISK SELF ASSESSMENT & AUDITING	290	420	425	390
20.	MEASUREMENT ANALYSIS AND IMPROVEMENT	220	335	235	225

Table 6.3.6 Survey 3 Part 1 Core elements ranking per total weight

From the table above participant's collected data analyzed for the scaled weight of each core element in order to create a detailed and reasonable evaluation of the results in Survey 2 where these core elements scored by the auditing collected data.

	TOTAL SCALED WEIGHT PER ELEMENT				
		SAFETY	QUALITY	ENVIRON	OHSAS
1.	NATURE AND SCOPE OF DECISION	3.43%	3.31%	3.55%	3.19%
2.	LEADERSHIP AND MANAGEMENT	13.22%	12.04%	12.62%	12.52%
3.	STAKEHOLDERS AND COMMUNICATION	4.23%	4.98%	4.54%	4.02%
4.	RISK SCENARIOS	2.63%	1.94%	2.29%	2.91%
5.	PERSONNEL RECRUITMENT AND TRAINING	12.42%	11.77%	10.19%	10.07%
6.	OPERATION AND NAVIGATION	3.52%	1.98%	3.64%	3.05%
7.	HAZARD IDENTIFICATION	2.94%	2.34%	4.58%	4.57%
8.	CARGO, BALLAST AND MOORING	2.14%	2.60%	2.56%	2.54%
9.	MANAGEMENT OF CHANGE	4.58%	4.59%	4.36%	4.34%
10.	PERFORMANCE STANDARDS	2.71%	4.06%	3.19%	3.46%
11.	RISK AND CRITICAL TASK ANALYSIS	3.96%	4.19%	4.09%	3.83%
12.	PLANNED MAINTENANCE	4.76%	5.25%	4.80%	4.67%
13.	RISK ASSESSMENT AND ESTIMATION	4.72%	4.72%	5.79%	6.37%
14.	RISK MANAGEMENT AND EVALUATION	5.30%	5.42%	6.20%	6.33%
15.	ACCIDENT INVESTIGATION AND ANALYSIS	8.41%	6.57%	7.32%	6.84%
16.	PURCHASING AND SUBCONTRACTING CONTROL	2.45%	5.07%	1.98%	2.08%
17.	RISK PREPAREDNESS AND PLANNING	11.17%	8.16%	9.34%	11.13%
18.	MATERIALS AND SERVICE MANAGEMENT	2.89%	4.37%	3.05%	2.40%
19.	RISK SELF ASSESSMENT & AUDITING	2.58%	3.70%	3.82%	3.60%
20.	MEASUREMENT ANALYSIS AND IMPROVEMENT	1.96%	2.95%	2.11%	2.08%

Table 6.3.7 Survey 3 Part 1 Core elements ranking per scaled weight

In Part 1 the participants have determined the critical core elements of all four management systems and their contribution to risk evaluation of the implemented management system. The elements were tested for risk contribution and ranked by the criteria of practicality and feasibility, uncertainty, control and monitoring for a risk based management system. The valuation based in literature review and participants knowledge based proportionally to the elements selected by its contribution to risk definition and management.
The results presented below.

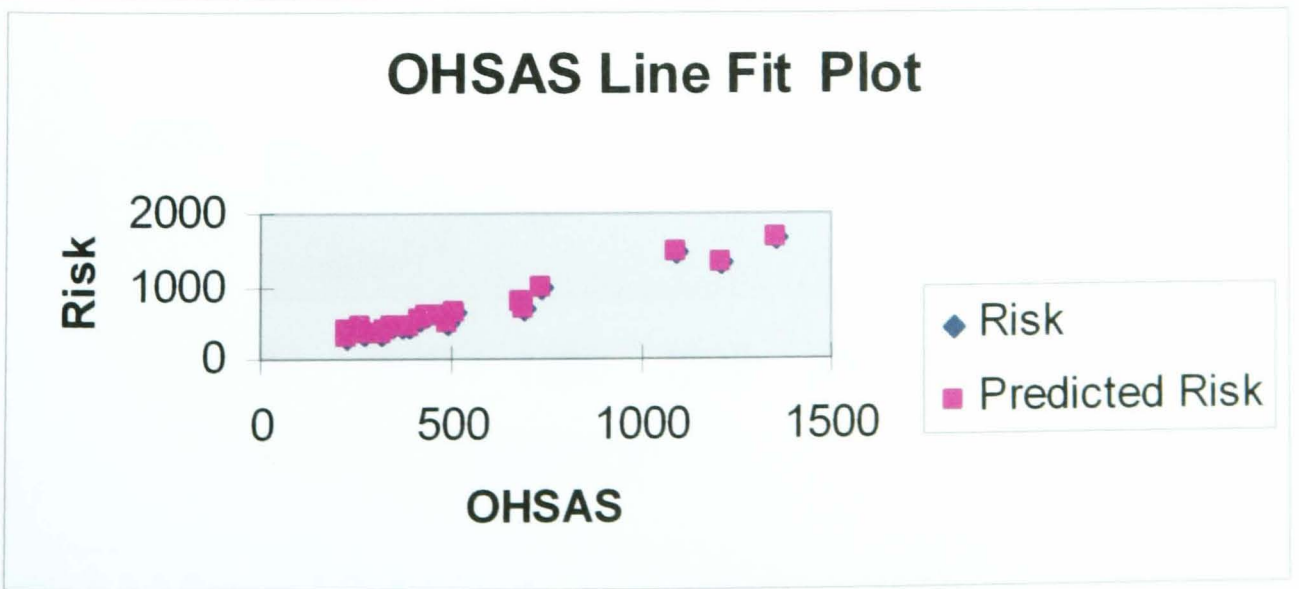
	RELATIVE RISK RANKING	25%	32%	19%	24%	100%
		Practicality	Uncertainty	Control	Monitoring	Risk
1.	NATURE AND SCOPE OF DECISION	80	30	55	70	540
2.	LEADERSHIP AND MANAGEMENT	295	225	250	220	2030
3.	STAKEHOLDERS AND COMMUNICATION	220	100	55	50	725
4.	RISK SCENARIOS	40	85	60	30	385
5.	PERSONNEL RECRUITMENT AND TRAINING	200	200	200	200	1720
6.	OPERATION AND NAVIGATION	40	35	90	60	480
7.	HAZARD IDENTIFICATION	50	180	35	40	570
8.	CARGO, BALLAST AND MOORING	50	40	100	35	390
9.	MANAGEMENT OF CHANGE	100	150	70	60	720
10.	PERFORMANCE STANDARDS	40	40	50	80	550
11.	RISK AND CRITICAL TASK ANALYSIS	60	120	100	60	650
12.	PLANNED MAINTENANCE	110	40	100	100	780
13.	RISK ASSESSMENT AND ESTIMATION	100	150	65	90	860
14.	RISK MANAGEMENT AND EVALUATION	60	80	150	120	930
15.	ACCIDENT INVESTIGATION AND ANALYSIS	70	80	90	180	1180
16.	PURCHASING AND SUBCONTRACTING CONTROL	30	40	80	60	470
17.	RISK PREPAREDNESS AND PLANNING	200	200	200	170	1580
18.	MATERIALS AND SERVICE MANAGEMENT	30	40	100	65	510
19.	RISK SELF ASSESSMENT & AUDITING	50	40	45	80	560
20.	MEASUREMENT ANALYSIS AND IMPROVEMENT	20	15	30	60	370

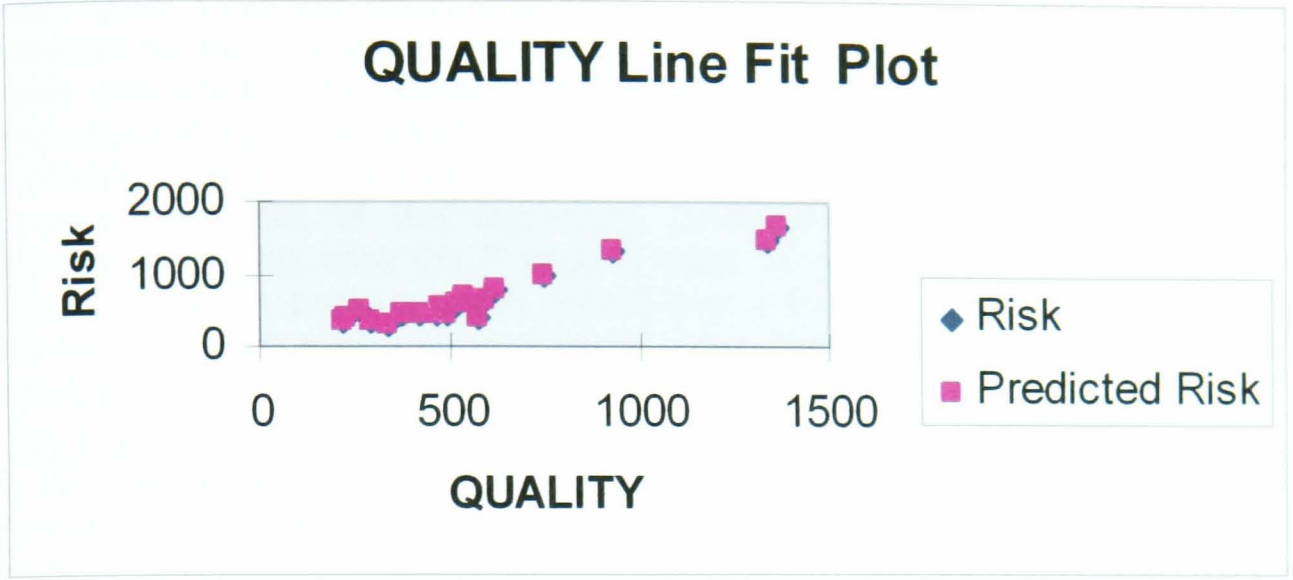
	CORE ELEMENTS	Relative Risk
		Score
1.	NATURE AND SCOPE OF DECISION	540
2.	LEADERSHIP AND MANAGEMENT	2030
3.	STAKEHOLDERS AND COMMUNICATION	725
4.	RISK SCENARIOS	385
5.	PERSONNEL RECRUITMENT AND TRAINING	1720
6.	OPERATION AND NAVIGATION	480
7.	HAZARD IDENTIFICATION	570
8.	CARGO, BALLAST AND MOORING	390
9.	MANAGEMENT OF CHANGE	720
10.	PERFORMANCE STANDARDS	550
11.	RISK AND CRITICAL TASK ANALYSIS	650
12.	PLANNED MAINTENANCE	780
13.	RISK ASSESSMENT AND ESTIMATION	860
14.	RISK MANAGEMENT AND EVALUATION	930
15.	ACCIDENT INVESTIGATION AND ANALYSIS	1180
16.	PURCHASING AND SUBCONTRACTING CONTROL	470
17.	RISK PREPAREDNESS AND PLANNING	1580
18.	MATERIALS AND SERVICE MANAGEMENT	510
19.	RISK SELF ASSESSMENT & AUDITING	560
20.	MEASUREMENT ANALYSIS AND IMPROVEMENT	370

Table 6.3.8 Survey 3 Part 1 Core elements ranking risk contribution

Regression Statistics						
Multiple R	0.999565					
R Square	0.999131					
Adjusted R Square	0.998899					
Standard Error	15.65187					
Observations	20					
ANOVA						

	df	*SS*	*MS*	*F*	*Significance*	
Regression	4	4225075	1056269	4311.633	9.37E-23	
Residual	15	3674.718	244.9812			
Total	19	4228750				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1.272587	9.346038	0.136163	0.893503	-18.648	21.19321
SAFETY	0.289591	0.049349	5.868274	3.09E-05	0.184407	0.394775
QUALITY	0.360601	0.03337	10.80599	1.79E-08	0.289474	0.431729
ENVIRON	0.433301	0.076446	5.66806	4.46E-05	0.27036	0.596242
OHSAS	0.351683	0.066172	5.314691	8.66E-05	0.210641	0.492726
RESIDUAL OUTPUT						
Observation	*Predicted Risk*	*Residuals*				
1	540.4751	-0.47511				
2	2008.854	21.1457				
3	714.3671	10.63288				
4	387.3061	-2.30612				
5	1761.786	-41.7858				
6	488.3386	-8.33858				
7	587.4635	-17.4635				
8	397.3554	-7.35541				
9	713.3666	6.6334				
10	541.1774	8.822581				
11	644.5266	5.473427				
12	780.1775	-0.17747				
13	869.8179	-9.81793				
14	935.2296	-5.22956				
15	1156.97	23.03028				
16	462.7107	7.289254				
17	1572.677	7.323452				
18	512.6472	-2.64719				
19	558.0158	1.984196				
20	366.7384	3.261557				





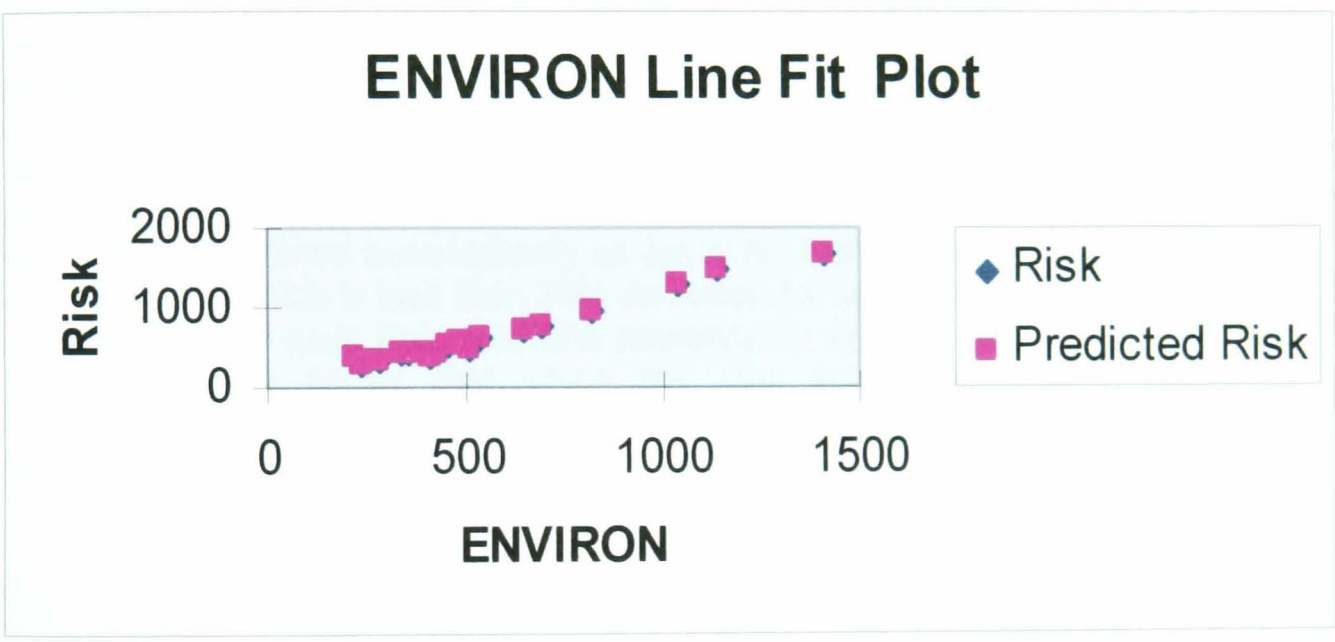


Table 6.3.9 Survey 3 Part 1 Correlation Risk Index and SQEOH

The results presented above provide evidence for strong correlation of the data collected for the core elements of SQEOH management systems and relative risk index estimated by the Survey 3 part 2. The graphs give identical projection of management systems elements 4 conditions and relative risk contributor and prediction. The R square emanated by the results representing the sum of the squares of errors of the regression considered effective as closer to 1 determined. In this case the R square value for each of SQEOH management system weight is positive which means that a linear relationship with IASMAR relative risk score explains the majority of the sample variance of the risk score which proves the strong relationship of the variables.

Part 2

In this case based in the identified 20 core elements the plan implemented to four participants companies by my colleagues for the verification of the results which have been collected provide sufficient data to test the IASMAR as a systematic risk management system tool incorporating the IASMAR risk score proposed in this research. The relative risk performance index resulted by IASMAR risk index score compared for relationship with actual scores. For all the elements the participants tested and received the following results. From the total results we could consider that the ranking queue of the companies participated is 2-1-4-3. The results presenting areas where the management should interfere for correction and adjustment in order to improve risk awareness and management. The areas determined automatically as areas for improvement by setting the risk success rating which is less than 20% deviation for conformity and 40% deviation for acceptance of each item and 30% deviation for score in total area. Where the level determined below that score the sign for further investigation and improvement appeared for risk based management system in that area.

***Table 6.3.20* SUMMARY OF THE ASSESSMENT RESULTS**

No	CORE ELEMENTS	SM 4	SM8	SM 14	SM 34
		IMPROVEMENT NEEDED	IMPROVEMENT NEEDED	IMPROVEMENT NEEDED	IMPROVEMENT NEEDED
1.	NATURE AND SCOPE OF DECISION	8	6	20	4
2.	LEADERSHIP AND MANAGEMENT	7	2	15	3
3.	STAKEHOLDERS AND COMMUNICATION	7	4	5	4
4.	RISK SCENARIOS	6	5	5	5
5.	PERSONNEL RECRUITMENT AND TRAINING	6	6	4	10
6.	OPERATION AND NAVIGATION	7	6	5	11
7.	HAZARD IDENTIFICATION	6	10	6	7
8.	CARGO, BALLAST AND MOORING	6	7	3	5
9.	MANAGEMENT OF CHANGE	4	5	4	5
10.	PERFORMANCE STANDARDS	1	5	4	3
11.	RISK AND CRITICAL TASK ANALYSIS	1	5	16	3
12.	PLANNED MAINTENANCE	2	6	13	3
13.	RISK ASSESSMENT AND ESTIMATION	4	4	4	4
14.	RISK MANAGEMENT AND EVALUATION	7	1	10	4
15.	ACCIDENT INVESTIGATION AND ANALYSIS	3	5	7	3
16.	PURCHASING AND SUBCONTRACTING	7	1	14	7
17.	RISK PREPAREDNESS AND PLANNING	6	2	15	5
18.	MATERIALS AND SERVICE MANAGEMENT	7	0	10	4
19.	RISK SELF ASSESSMENT & AUDITING	3	0	5	10
20.	MEASUREMENT ANALYSIS AND IMPROVEMENT	3	0	11	5

From the below results it is obvious that IASMAR score is a reliable and systematic way to identify management's system risk level and weak areas.

TOTAL	101	80	176	105
STD DEVIATION	25.25%	20.00%	44.00%	26.25%
SUCCESS RATING	2.96	4.00	1.27	2.81
RANK	2	1	4	3

Total score only in one company found below the success level of 40 % and in an about 27 % of the total core elements of the system. The IASMAR score identified also areas needed improvement in elements when companies seemed to have high conformity in the management system by comparing the success factor of each element to the IASMAR score. The IASMAR scores are completely consistent with pre assigned and represent the each management system researched area. As presented previously there were some potential limitations of this particular study. Two major limitations include the quality of the questions representing the areas of investigation and the reliability of the subjective opinion replied to these questions since the sample was considerably lower than the previous studies. In addition , the investigation of the sample data revealed the non –normality of the questions to the participants with different background. A more diversified questionnaire should be issued relatively to the implemented management system background at every level of the core elements. This absence of background similarities violated the assumption of common level of comparison since each management system develops a different level of managing risks. However even this non normality existed among participants a caution has been taken to interpret replies in an objective way so as the method assessed and found robust and valid and the areas for improvement identified and treated by the participants and fairly quick improvement made and development effected. In this Part 2 of the survey outlined the development of the application of the IASMAR relative ranking as verification method used in this research. Based on the auditing collected data the model of the ranking score was developed and compared the deviation with pre assigned score and recommendation made based in the risk factors. The application of IASMAR score involved risk quantification impact in SQEOH management system. After the quantification of risk impact, additional control options should considered guided by the investigated area and the perception of the core element objective. Finally a systematic corporate risk management system prototype established by determining more than 400 question/areas using the IASMAR score and the process of reiterate loop with part 1 of this survey provides a reliable tool of predicting potential incidents in weak areas for the each one of the SQEOH management systems as a continuous cycle and should start at the specific issue risk management by using a risk based management system. The survey conforms with the objectives of the research since a risk based auditing system is developed for all elements of all SQEOH management systems and analyses systematically the core elements and prioritizing weak areas needed additional control measures by improving awareness and knowledge in risk management. It has also developed mine and my colleagues professional skills and expertise in risk auditing which is a unique professional capacity in maritime industry. It has

also provided evidence by the participants that IASMAR model is a hierarchical, sequential and iterative process by the results of which the effectiveness and efficiency of the implemented management system improved and an excellence in professional practice achieved.

Sectional achievements from Survey 3
▪ In the Part 1 the IASMAR scores determined by literature review and the analysis and synthesis of information received so as a risk relative score determined and correlated to the SQEOH core elements valuation. The weighting for each of the 4 management systems considered under implementation made by the method of relative significance providing a combined table for the 20 core elements. The assignment of relative risk ranking score found to have strong correlation of the data collected for the core elements of SQEOH management systems as well as the relative risk criteria determined in the previous chapter 5 by the literature review. The risk prediction also defined per management system and correlated variables values, so as the probability of an incident related to safety, quality, and environmental and occupational health implemented management system could easily predicted under these values for the core elements which considered also benchmark values. The criteria set tested and found strongly correlated to risk definition and management of weak areas of the implemented management system. ■ In Part 2 verification of the determined scores made by collecting data from participants which compared to relative risk index score benchmark. A reliable way to retrieve these values found to be the IASMAR auditing collected data by 400 scores and the assessment on standard deviation taking into consideration the success factors with is 40% for each element and 30% for each part. Participants replies proved that the IASMAR score and risk quantification is a unique and reliable tool for identification of weak areas of implemented management system for risk identification analysis and management. It is also a tool by which organisational improvement and professional excellence achieved. The Survey 3 fulfils the aims and objectives of this research as mentioned above since relative risk index defines the level of risk index corresponds to risk performance and risk management success factors on implemented management system weak areas. It is also a risk based auditing system which develops a systematic risk management approach and a methodology for corporate risk management implementation. It prioritises actions and measures should be taken in weak management areas and provides a report to compare with benchmark values for the degree of actual risk management success. It is also developed mine and participants professional capacity to an advance level of expertise in evaluating properly financial, operational, human and technical multiple functions and have contributed substantial knowledge among interested parties in maritime industry.

Table 6.3.21 Survey 3 Part 2 Sectional Achievements of Survey 3

CHAPTER SEVEN : CONCLUSIONS-RECOMMENDATIONS

This chapter completes this research study by presenting research conclusions and recommendations. The research objectives are first reviewed and specific conclusions relating to whether or not the research data supports the conditions set then discussed. Recommendations are made based on research results and potential areas for future study are identified. The contributions of this research are discussed at the end.

7.1 Review of Research Aims and Objectives

As identified in Chapter 4, this research effort had five primary aims which were:

1. To design a risk ranking and auditing system and to develop a systematic risk management approach based on the IASMAR .
2. To establish a methodology and database for activities and corporate risk management research.
3. To identify and prioritize the level of awareness and ability of implementation of risk elements steps and impact of ranked specific activities and core elements of the IASMAR.
4. To provide with a report and further validate the IASMAR through testing by measuring the level of risk in specific activities and corporate risk management and define the degree of actual management's success.
5. To develop my own professional capacity to an advanced level of expertise and contribute substantial knowledge among interested parties in maritime industry.

The following five sections present a detailed discussion of these five aims and relative objectives.

1. To develop a systematic risk management approach

To design a risk ranking and auditing system and to develop a systematic risk management approach based on the IASMAR .

Maritime Risk management process consists of three major tasks: risk identification, risk quantification and risk monitoring & control. It is shown in this research that the IASMAR can be effectively used in all of the three risk management processes for specific shipping activities and corporate risk management. The shipping activities with associated hazards as well as the core elements of a risk based management system identified, the risk level quantified in a applicable way and risk results for each one of the activities and elements and the correlation between the values of safety, quality, environmental and occupational health impact and risk index, success index and success level monitored and verified. The correlation tested and proved that risk level could be predicted under certain values of risk SQEOH cause contributors. The main benefit of such prediction lies not in absolute figures predicted but in the ability to determine assessment in a practical and reliable manner by using possibility

theory. The documentation of these findings establishes a systematic risk management approach and tool developed and based on these findings. By applying the risk auditing model developed by IASMAR and adopting the format of case studies planning process flow diagram a systematic risk management process using risk definition core elements has been developed. The structure is presented in the below flow chart. There are proposed 20 core elements to establish and assess the implemented management system under the risk perception for four major sub-processes in the proposed risk management model: risk identification, risk quantification, risk control, and risk monitoring. Each element consists of a series of 20 areas that are deemed important in that process and which are quantified and compared with the pre assigned values to define the actions' level in weak areas for further improvement. The IASMAR is used in all four stages of the proposed risk management model for shipping activities and system's core elements and the process may be used one or several times for the improvement of the management system. The development of this unique systematic risk management system using IASMAR meets the first objective of this research.

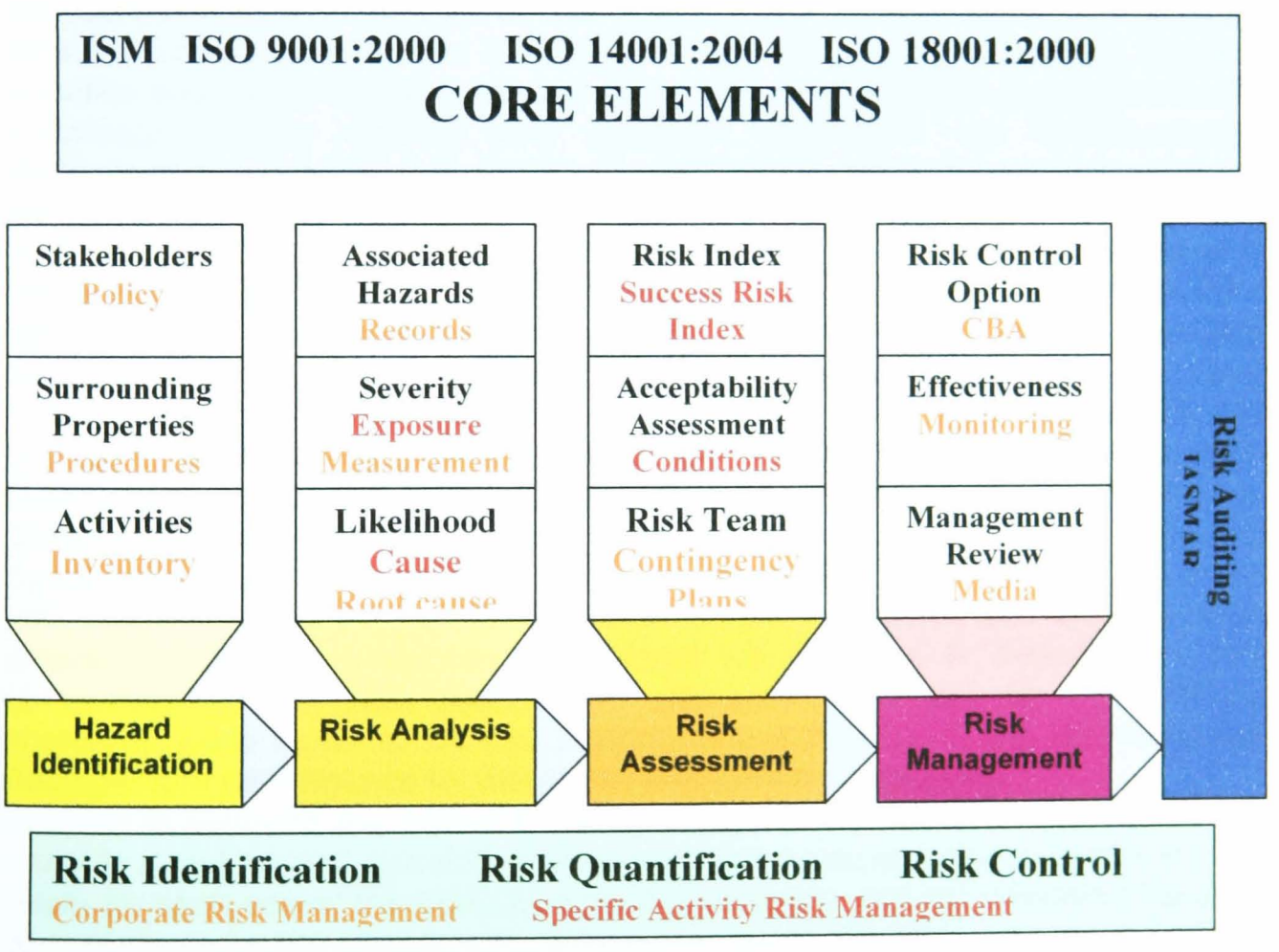


Table 7.1 ISO Core Elements and Risk management sequence

2. To establish a methodology and database

To establish a methodology and database for activities and corporate risk management research.

The second research objective was to establish a baseline methodology and database for follow-up research. The methodology established included action

research, soft systems methodologies, IASMAR benchmarking, data analysis in the form of regression modelling and correlation analysis. This methodology is unique in maritime risk planning research and provides a basis for shipping activities risk analysis and corporate risk based management for the maritime industry. Two databases and a vast amount of data pertinent to risk contributors of SQEOH management system developed for 8 types of ships mostly used in maritime industry were developed for follow-up research: specific activities success and risk index database and core elements auditing collected database. These two datasets both had data stored in software MS Excel Analyse it tool pack for processing and results. All data are ready for any follow-up research or benchmarking studies deemed relevant.

3. To identify the impact of activities and core elements

To identify and prioritize the level of awareness and ability of implementation of risk elements steps and impact of ranked specific activities and core elements of the IASMAR.

The third research objective was to identify and prioritise the level of awareness and ability of implementation of maritime risk factors and variables and their potential impact and relation to risk level with associated hazards in shipping activities and core elements based on data collected. The level of awareness and knowledge clearly defined and potential constraints on implementation determined successfully. Actual project's risk levels were analyzed to determine if there were risk elements that distinguish between successful and less-than-successful management. This level considered as conformity when risk level is below the predefined and improvement needed when is above. Results on core elements risk level were ranked by their success factors performance into successful and less-than-successful in risk management. Then actual risk level averages of core elements between the departments were calculated and compared. Significant differences between the levels of the two risk indexes were determined using std deviation comparison. If the risk levels between the two participants companies were different, the magnitude of difference was measured by the size analysis of the effect. The results showed that maritime companies with better performance did better in defining certain scope in core elements than others. Moreover, risk elements 7: Hazard Identification, 3: Stakeholders and communication, 13: Risk assessment and estimation, and 10: Performance standards were found to be risk performance indicators in the corporate risk management performance for integrated maritime management.
In order to estimate the potential risk level caused by activities with associated hazards a ranking and correlation of success risk index and risk level defined and made for each one of the SQEOH contributors taking into consideration the level of confidence for the exposure in participants estimates. Each one of the 8 ship's type level of risk for each shipping activity assessed and risk exposures as a result of predicted values defined by using least squares linear regression method and ANOVA techniques was explored to model the sample data. The predicted values of success risk index found to be strongly correlated with risk index values providing evidence of coherence and quality in risk parameters interpretation. Each one of the critical core elements ranked for their contribution to corporate risk management system and weighted for contribution to each one of safety, quality, environmental and occupational health management system.

Relative risk index defined by the criteria set and through auditing collected data verified the level of conformity of the management system. The results given in Chapter 7 showed that these models can be applied effectively to summarize and present the data and can be used to estimate risk success factors performance based on given IASMAR scores. These findings meet the third stated objective of this project's research.

4. To validate the IASMAR

To provide with a report and further validate the IASMAR through testing by measuring the level of risk in specific activities and corporate risk management and define the degree of actual management's success.

The IASMAR for maritime risk management was validated as an effective risk management tool using a sample of almost 50 ship related companies at a first stage and 32 in a second stage representing approximately 2.2 million of DWT in 8 different types of ships. The IASMAR for specific activities risk assessment was validated through a sample of 32 ship related companies representing approximately 1.2 million DWT in total fleet. This research effort continued the data collection and IASMAR validation using an expanded data set. As a result, a total of 82 ships related companies and 78 ship management data were obtained for the analysis of this research.

The integrated management system validation method was adopted for this research. In order to determine the effectiveness of the IASMAR in predicting weak areas identification success, linear regression analysis was conducted for both specific issue and corporate risk management systems between success risk index and risk index values as well as core elements weighting and relative risk index. The project success was measured by success index, which was calculated by using risk factors for safety, quality, environmental care, occupational safety and health and risk proactive management. A risk success-ranking index provided evidence of risk based management system competency and relative ranking of companies affected based on efforts by the participants to contribute to project success.

With the IASMAR SRI score as independent variable and risk index factor as dependent variable, bi-variate linear regression analyses have been further conducted to validate relation with risk index in addition to qualitative interpretation of risk level. In my research the results of the analysis using IASMAR success factors; success risk index and relative risk scores measuring the success of definition of risk level and demonstrated a significant performance for both specific issue and corporate risk management. The results were consistent and coherent with existing risk management previous research methods and results used and proved that the IASMAR is an effective risk management tool and subsequently meet the fourth objective of this research.

5. To develop professional expertise and knowledge

To develop my own professional capacity to an advanced level of expertise and contribute substantial knowledge among interested parties in maritime industry.

My involvement and role in devising technical, operational and administrative risk based decisions in Maritime management gave me the opportunity to deal /

handle and solve a wide variety of cases and aspects of safety, quality, environmental and occupational health management, which have provided inspiration and motivation for the proposed approach of the research described above. Within my assignment for this project I have utilized my 25 years professional experience and skills, knowledge and capabilities acquired and developed providing me with the ability and capacity to undertake and conclude successfully this programme. In all the stages of my project I referred extensively to relationship I have developed with my colleagues and participants with whom I have reviewed and supervised this project as a team leader and Manager and enhanced my research experience and my capacity to undertake this major project. During the research I have learnt a lot for things I had heard but I had not that depth of knowledge. Also I attended valuable training courses and seminars and the results gave me confidence that I am able to manage, plan and materialize a major project by carrying out critical literature review and by following a systematic approach for design a program, effecting data collection and analysis integrating research aims, following data requirements and methods of collection and analysis, taking into consideration ethical and other constraints and finally to meet level 5 descriptors. The risk-based decision making management was basically the core element process of my research and as such it was the problem-solving development process which gave me the knowledge in order to identify and experience the technical parameters and the commercial conditions of safety, quality, and environmental and occupational health management system. Since the commencement of my research I have been involved in training, qualification and certification for auditor for ISM, ISO 9002, ISO 14001 and OHSAS in my Company. This introduced me in the systematic world of approaching safety, quality, environmental and occupational health aspects and transformed my experience in to a powerful capacity to develop and evaluate systematically the management performance. The auditing system in my company enables the development of my experience to codes and enhance continues improvement of all participants involved by giving the capability to handle and assess professionally and systematically all the goals by their companies. My additional background as Dipl. Engineer in mechanical and electrical engineering in combination with MSc. background in Maritime Management and Engineering assisted me to define scientifically the scope of my research. Since the main issue was the preparation, review and implementation of the IASMAR project for various types of ships in participant's companies the definition of awareness and knowledge level of my participants and colleagues dealt with the risk management structure was critical and their efforts contributing to the project success significant. The results and verification for ranking and analysis of activities and elements created a well based scientific frame and background and the audit review process have assisted me mostly to develop theoretical knowledge, get perception of the research process and methodology so as to feel confident to conclude the actual project's research that fulfils fifth objective requirements.

Two research conditions were also established and discussed. The conditions were developed based on the results of literature review, problem statement, findings of previous specific activities and corporate risk planning research. The conditions are set up to extend the usage of the IASMAR from an auditing planning tool to a risk management tool in the early stage of integrated maritime

management system. For first condition has been notified that by adopting success measures from activities risk ranking and management system core elements relative risk indexing measurement were identified for measuring compliance success in relation with the IASMAR relative risk score for Ship's safety, Environmental protection, Quality of services, occupational health and success rating which found in compliance with estimates.
The results of the least squares linear regression analysis using the IASMAR success risk index presented by causes- exposure scores and risk index measured by the probability demonstrated a significant correlation and supported the first research condition. The results showed that as the IASMAR risk success score going closer to risk index, the probability of risk prediction and risk management success increases. In addition, the regression results shown in Chapter 7 indicate strong relationship between IASMAR scores as Success Risk Index (safety, quality, environmental and occupational health) and calculated Risk index score. Also a positive relation between relative risk index valuation and weighting identified producing a benchmark for core elements contribution to risk definition and management. It was statistically shown that as IASMAR success risk index for project's score increases (for corporate risk management), the exposure decreases.
In Chapter 5, management system and IASMAR score are analyzed for the 20 critical core elements. By comparing the actual ranking score and nominal score for the core elements with their IASMAR resulted scores, it is shown that elements with higher success factor score (better risk definition) have less risk exposure. Taking into consideration the additional control measures needed to reduce risk a cost saving emanated and should properly evaluated as a measure of project's performance and success which supports the first research hypothesis by showing that by implementing IASMAR and adopting results a real cost saving for the additional required control measures effected and better planning in the company's contingency plans. However, some of the potential limitations of this analysis are acknowledged. The primary limitation relates to generalizing the audit characteristics to a larger population since each ship functioning by its own technical and commercial characteristics. In this study, data selection was based on maritime companies volunteering to implement risk based management systems other than ISM and not on a random selection process; companies may have selected management system's elements with a bias toward performance and cost saving, which may have influenced the results. In the mean time, the results provided by the maritime companies are giving a generic approach and may deemed better to generalize the auditing characteristics and results to a larger area within the company.
For the 2nd condition the sample audits were categorized into groups based on their ship's type. The success risk levels were compared between these groups for which the Risk Index determined as per IMO guidelines. First, the significance of the success risk index difference was tested and determined in comparison with risk index for the benefits and performance for assessing risk level. Then the risk level correlation determined for these identified activities. The success risk index determined for safety, quality, environmental and occupational health and matched with the risk index level. In the corporate risk management the core elements identified to contribute to risk management have significant risk level difference and its standard deviation was identified as indicator of poor

performance. The relative risk levels and risk success rating can be related to safety, quality, and environmental and occupational health performance. Two models were established and then applied to estimate prediction risk level versus calculated by IASMAR score. The results showed that not only the probability of the risk but also the severity of the consequences caused by the risk exposures can be estimated adequately.

7.2 Conclusion

The IASMAR ranking system has been developed and implemented to a limited sample of four maritime companies and effectively improved decision making process and accomplished the previously discussed aims and conditions by ranking shipping activities and weighting risk management core elements for demonstrating continuous improvement in the existing safety, quality, environmental protection and occupational health management system. The use of IASMAR as an activity-task oriented system attempted by employing a ranking-weighting system to evaluate risk level of the activities and effectiveness of the management system and also seems that is capable to define risk level in decision related information and technical approaches used without disrupting intuitive established common risk practices. The rating generated from this evaluation is limited due to the size of the sample, but when implemented had better measured the company's SQEHMS performance against compliance requirements and was adherent to maritime best practices for decisions of daily operations. However, the practical decision support of IASMAR tool based on risk ranking and risk level analysis methods had only been developed in the present project to my company and a limited number of participants by providing new perception or risk level, new self-assessment plan, new approach in risk management and new safety culture development.

In the IASMAR project investigated adequately the level of awareness of risk management process among the participants' maritime companies as well as the capability for proper implementation taking into consideration the forthcoming legislation in maritime industry. The results beside the size of sample, which was limited, proved that the existing level of awareness seems to be below the satisfactory level and concluded that many efforts in training and drills should spend up to an affordable time of implementation of two tiers as resulted by the first survey with 3-5 years time schedule. In addition, for establishing requirements in corporate risk management additional care should taken in conformity with the rest implemented management systems. In my project has provided a detailed assessment of current conditions by eight presented sectional achievements in survey 1 and advanced knowledge of existing level of risk management awareness, scope definition and common metrics that determines the potential ability of participants to effectively implementing risk management.

In the IASMAR project presented an integrated risk management plan which is activity and task oriented and by defining success risk index based in possibility theory seems to be strongly correlated to FSA Risk index but also add qualitative characteristics which interpret successfully and categorize risk level by the exposure (benefit, requirements and liability) and not only by consequences. In the IASMAR, specific activity risk management dynamic inventory lists obtained

and probably could incorporate with associated risk management tasks and furthermore all these could be integrated in a risk based management system supporting decision-making process. In the corporate level, IASMAR could be used to accumulate corporate risk data and experience during its risk based auditing system and could be efficiently implemented in combination with other management systems such as ISM, ISO and OHS.

In the IASMAR project a self assessment plan developed based on risk relative core elements weighting and ranking in combination with corporate experience and performance levels for problem solving of preventive or mitigating plans as a benchmark and providing a risk based decision modelling in action and in real world for demonstrating continuous improvement in implemented management systems. Beside the limitation of the sample, it seems that could improve efforts for company's continuous improvement.

In the IASMAR, risk management system, the monitoring process, when, where applied, proved that can be combined with the actuality and necessity assessment, and further with CBA methods. Also seemed that could provide adequate assurance that there would be properly selection of controls in company's activities, which is the necessary factor in the implemented management system with the procedures for risk management that are understood and followed.

In the IASMAR risk auditing and review process which was implemented in a group of four companies and needed further testing and verification, initially determined that:

- The areas focused resulted by a reliable gap analysis of what was intended by the procedures adopted and information gathered through the audits for the assessment where areas with risk level defined as below benchmark values "Needed further improvement"
- The improvement of knowledge of risk level in management areas would have help decision makers to reach better decisions and identify what lessons could be learned for future assessments and management of risks
- A development in safety culture could be achieved for the duty of care in safety, quality, environmental and occupational health to the ship and shore employees.

In the IASMAR case studies, risk level category benchmark weights were obtained from the participant's data working with SQEOH issues by using risk ranking and weighting techniques. The results showed that resulted weights emanated from participants did not differ widely.

Several problems rose with maritime companies willing to implement the integrated IASMAR as a tool of the decision-making and risk management. Where companies have implemented auditing for SQEHMS system the complicated process of risk auditing, even in most of the times has been successfully implemented, proved a new experience for ship managers. In most cases, little guidance was available on specifically how to evaluate compliance with risk management standards and even less guidance was available on how to evaluate effectiveness when implementing a risk management system. Additionally no commonly accepted weighting and ranking system was available to rate risk and self-assessment performance. In maritime industry, all the standards conceptually are performance-based but for risk management there

have not set common performance indicators and for that, it is difficult to conduct an audit unless specific goals have been set to measure performance.
The benefits of the IASMAR auditing system, which obtained in my organisation during implementation, include:

- An inventory of activities, tasks, core elements and assessment criteria.
- A more comprehensive auditing system in risk based core elements in implemented management system's weak or improvement-needed areas.
- A management tool of encouraging continuous improvement in daily operations, particularly beyond minimum compliance levels.
- An innovative common measure of risk level and risk based management system effectiveness for minimisation or elimination of claims.
- An effective risk based corporate QSEM management and auditing system, which will improve company's compliance with standards and create a mechanism for continuous improvement and cost effectiveness.

The IASMAR project tested to prove how an integrated risk assessment, auditing ranking tool can succeed in defining levels of compliance, setting goals for improvement, comparing safety improvement status among maritime companies, and create more uniform assessments. A number of different methods to collect and analyze the data utilized in the project's research. Performance results and IASMAR data collected finally from a fleet of eight types of ships representing approximately 1.6 million tonnes in total capacity DWT analysing a small but representative sample. The amount of collected data was significant and proved to have results where implemented for a period in various stages. The implementation by using various statistical techniques as well as qualitative analysis techniques has provided acceptable results. In addition, a systematic risk management approach using the IASMAR tested in a risk process flow diagram, which in this report initially presented and discussed in details. Three fundamental conclusions reached:

- The completeness of IASMAR project in risk definition, common metrics and management during awareness survey of risk steps has a significantly and positively effect on overall risk management surveys success.
- There have been defined specific core elements related to risk management in the IASMAR that the participants could audit, rank and evaluate in order to achieve a significant and positive effect on risk management success.
- The IASMAR is an integrated and effective risk management plan for maritime companies. This could be applied during the implementation of a risk based SQEOH management system.

7.3 Contributions

The IASMAR research is innovative in nature and contributes by extending the knowledge of maritime risk management in risk level definition, metrics, assessment and management. This investigation extended the existing research by focusing on the shipping activities and associated tasks deriving IASMAR in different phases of risk management process. Major contributions of this research include:

1. This study, where implemented, demonstrated that completeness of element's evaluation in management areas has possibly a significant and positive effect on risk management success. No previous research investigation using the IASMAR

had as many sample maritime companies as this study. The participants from the maritime community was limited but offered a unique sample within implemented management system. The research contributes significantly to the risk management awareness and knowledge by providing in-depth analysis and empirical evidence for the evaluation of management system's core elements, which is important and has a positive effect on shipping and operational outcomes, including improvement of weak areas and losses predictability as well as optimisation and proper allocation of resources.

2. The project's approach in risk management was particularly based to an activity and task oriented network. The statistical analysis used has summarized the risk weighting benchmark of the core elements, which is a new way to measure the level of risk based management system development. Specific critical activity and CRM have integrated and provided an effective decision making process timely supported for improving cost saving, adopting new requirements and handling successfully liabilities for crew and ship's property. There was no comparable research found during the literature review. This study contributes to the current body of knowledge by showing details of management areas and activities weighting development practice for the maritime companies.

3. The study seems to contribute to the present status of knowledge by identifying activities, tasks and core elements that have significant effect on achieving risk management success. The risk team can use this information to the risk based decision-making process, to help focus their limited resources on the issues with larger impacts on ship management outcomes and finally to protect company's interests against legislative liabilities and insurance exposure. The results provide specific guidance to risk management teams wishing to address risk evaluation definition during risk management process.

4. The new self-assessment plan developed based on core elements affecting risk awareness and management implementation in combination with corporate experience and performance levels for problem solving of preventive or mitigating plans and providing a risk based decision modelling in action and in real world for demonstrating continuous improvement in implemented management systems. The systematic risk management approach using the IASMAR developed in this research tends to provide a prototype track map for risk management process during risk based management system implementation. It successfully combines the usage of the IASMAR and ISM or ISO management process.

Maritime Companies participated in this research reported up to now that the adoption of a risk based integrated managed system provided the following benefits:

- IASMAR is a risk based integrated approach that meets the implemented management system requirements of recognized safety, quality, health and environmental protection international standards and codes and legislative and regulatory requirements for prudent management.
- IASMAR promotes the development of continual improvement philosophy by supporting an iterative process of self-assessment measurement and evaluation of activities and weak areas towards improving management performance and reducing or eliminating claims.
- IASMAR definition and investigation of maritime activities and related hazards assisting maritime companies in identifying and predicting SQEOH performance gaps.

- IASMAR provides a structured process and an evaluation system that can be integrated towards enhancing existing management system to effectively improve SQEOH performance and substantially reduce potential accidents.

7.4 Recommendation for Future Research

Through the course of this research effort, several areas have been identified as potential areas for future study. The first is in the area of improving the data collection process by improving the sample of maritime companies participated. One major limitation of this research is due to the nature of assessment in case studies. If the information is collected, the quality of this information heavily relies on human perception. As such, a certain degree of error is expected. Using a wider sample and by collecting "real time" information from an ongoing process should significantly enhance the reliability of the data thereby increasing the accuracy of any conclusions that can be drawn from the analysis. More maritime companies with particular fleet of particular types of ships such oil tankers, chemical tankers, gas carriers should taken in to consideration as first importance due to high liabilities connected to the nature of its operation. Additional extend sample of companies managing bulk carriers, containers, reefers, general cargo and car carriers wishing to improve their risk management planning process should participate since can greatly benefit from using this approach in their benchmarking effort. Further analysis in various areas can benefit from an improved level of survey instrument and increased participant's number. Detailed information concerning the shipping activities, risk analysis methods and associated hazards should defined with an improved survey so that correlations between the IASMAR and other variables (trading area, fleet size, and training period) can be found. This will increase the reliability of the IASMAR in predicting risk based management system's performance, including losses and failures predictability and effective management. An initial effort was performed for the risk management of the implemented management systems according to safety, quality, and environmental and occupational health standards. This investigation utilized scoring and weighting methods to model the participant's data. The results obtained are satisfactory for an initial exploratory study. Alternative modelling approaches may better describe the qualitative characteristics of the data on hand are recommended. The production of risk management manuals with procedures and relative records will greatly assist future research by providing more quantitative and objective data. In any case, from the project concluded that assessment mostly based on the specific trading conditions for which knowledge of legal and commercial framework needed for further detailed investigation. A further research for combination of specific risk activity and proper risk analysis techniques or methods will definitely explored and initial efforts showed promising results for further future analysis.

Finally, my intention is to present and publish the elements of my research under the title: "The Duty of Care in Shipping".

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INTEGRATED AUDITING SYSTEM FOR MARITIME RISK MANAGEMENT

IASMAR®

By Dr. Konstantinos Rokkos Dipl. Eng. MSc.

The project of the integrating auditing system for maritime risk management (IASMAR) promotes new perception, alternative methods and innovative ideas such as:

ADVANCED awareness of existing level of risk management, scope definition and common metrics so as companies could effectively implement risk management.

NEW perception of risk and risk assessment since lately proposed risk assessment methods and techniques uses probability theory in which a single number is used as the likelihood in qualitative or frequency in quantitative presenting the probability and describing in a scale how likely an event is to occur. Probability is the outcome of a random event which normally cannot be determined before it occurs, but it may be determined by any one of several possible outcomes. The actual outcome is considered to be determined by chance and rated in a scale. In this particular project firstly presented the possibility of an event by using the data available concerning the problem of activity under investigation, in which it is often possible to obtain a list of all potential, a priori possible options and solutions. The final step then consists in minimising or eliminating the possibilities that are not actual solutions under proposed preventive or mitigating measures. Assessing possibility has been chosen as a more suitable risk management tool adapting the complexity of multivariable shipping environment. Possibility assessment uses three concepts, the possibility the actuality of an event and the necessity of measures should be taken. This provides an absolute new concept which is used to manage effectively and efficiently the actual risks and response to aims, requirements and liabilities related directly to the company's interests.

NEW approach in risk management based in an activity and task oriented network for which specific critical activity and corporate risk management integrated and provide a feasible and effective decision making process timely supported for improving cost saving, adopting new requirements and handling successfully liabilities for crew and ship's property.

NEW self assessment plan development based on core elements affecting risk awareness and management implementation in combination with corporate experience and performance levels for problem solving of preventive or mitigating plans and providing a risk based decision modeling in action and in real world for demonstrating continuous improvement in implemented management systems.

NEW safety culture development for the duty of care in safety, quality, environmental and occupational health and safety issues to the ship and shore employees.

NEW PERCEPTION, NEW IDEA, NEW APPROACH