A RISK BASED APPRAISAL OF MARITIME REGULATIONS IN THE SHIPPING INDUSTRY

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for the Degree of Doctor of Philosophy

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Abstract

The risk of the excessive and inadequate implementation of maritime regulations that have been introduced by the IMO has been widely recognised during recent decades. The world has been separated into various geographical regions according to the thoroughness by which states implement the maritime regulations. Nevertheless, some ship managers endeavour to find an opportunity to make their ships more profitable by reducing relevant costs, which would otherwise have been generated from maritime regulations, so resulting in less safe ships. States facing difficulties in establishing high levels of standards need to motivate private stakeholders to become more involved in the processes of regulation implementation. Evaluating the implementation performance of maritime regulations can improve the current regulatory process to the benefit of ship safety.

In order to improve the implementation performance of a maritime regulation this research has adopted the Balanced Scorecard (BSC) in developing a performance management system for the shipping industry and its stakeholders. The framework consists of two groups of BSCs, one for the IMO and the other for a ship operator who is a representative example of a stakeholder. Each group contains a number of BSCs with their own 'perspectives' and 'measures'. The framework has been developed following an extensive literature review and one survey for a broader verification of the proposed BSCs from industrial experts. By using a variety of mathematic methods such as Analytic Hierarchy Process (AHP) and fuzzy set theory the framework from BSCs has been further developed by introducing two tools, one for the IMO and the other for a ship operator. The stakeholders can have an effective but simplified measurement system for a variety of applications. Both tools have been tested through case studies and a survey to demonstrate their applicability and efficiency.

This research has revealed a number of very significant conclusions. The most important conclusion is that the states have the highest weight in the regulatory process. However, the contribution of all private stakeholders is also very important. Another conclusion is that the stakeholders will themselves become motivated to

assist flag states in the regulatory process, provided that such regulations do not generate an excessive cost, particularly so when their results are either ambiguous or of relatively small significance. The third conclusion from this research is that the shipping industry is unfamiliar with effective management systems, which enable to combine regulations with profits. The introduction of such systems will highlight to a stakeholder any issue, which may bring about a positive commercial advantage by implementing a specific maritime regulation. The fourth conclusion is that due to the rapid changes which happen in the shipping industry the current regulatory system and the stakeholders interaction may be somewhat different in future times. Consequently, the introduction of the proposed tools should be followed by regular industrial reviews.

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Glossary

ABS	American Bureau of Shipping: The ABS is a classification society, with a mission to promote the security of life, property and the natural environment, primarily through the development and verification of standards for the design, construction and operational maintenance of marine-related facilities.
AHP	Analytical Hierarchy Process: AHP is a framework of logic and problem solving that spans the spectrum from instant awareness to fully integrated consciousness by organizing perceptions, feelings, judgements and memories into a hierarchy of forces that influence decision results.
BSC	Balanced Scorecard: The BSC is a performance management tool for measuring whether the smaller-scale operational activities of a company are aligned with its larger-scale objectives in terms of vision and strategy.
CI	Consistency Index: An index that provides a measure of the consistency for pairwise comparisons of a matrix.
CR	Consistency Ratio: CR of a matrix can be indicated by comparing the inconsistency of the set of judgments in that matrix with what it would be if the judgments and the corresponding reciprocals were taken at random from the scale.
Crisp Number	A precise numerical value.
EEZ	Exclusive Economic Zone: EEZ is a seazone of 200 nautical miles from shore over which a state has special rights over the exploration and use of marine resource.
EU	European Union: The EU is an economic and political union of 27 member states, located primarily in Europe.
FOC	Flags of Convenience: A flag state with lax regime that allows ship owners who are not citizens of that state to register their ships in that state.
FSA	Formal Safety Assessment: FSA is an approach adopted by the IMO to support a systemic and structured assessment of proposals for new international regulations to improve shipping safety.
IACS	International Association of Classification Societies: IACS is a gathering of ten major classification societies.
IMO	International Maritime Organization: A special agency of the United Nations with responsibility for improving maritime safety and preventing pollution from ships.
ISM Code	International Safety Management Code for the Safety of Ships and Pollution Prevention: The ISM Code is an amendment to the SOLAS Convention on minimum safety management requirements for ship managers.
ISO 9001	A Quality Management System set by International Organization for Standardization.

ISPS Code	International Code for the Security of Ships and of Port Facilities: The ISPS Code is an amendment to the SOLAS Convention on minimum security arrangements for ships, ports and government agencies.
ITOPF	International Tanker Owners Pollution Federation Limited: ITOPF is a non-profit organisation established on behalf of the world's shipowners to promote an effective response to marine spills of oil, chemicals and other hazardous substances.
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978: MARPOL 73/78 is an international treaty that provides regulations regarding ships safety pollution prevention.
MCA	Maritime Coastguard Agency: MCA is a UK executive agency working to prevent the loss of lives at sea and is responsible for implementing the UK and International maritime law and safety policy.
MOU	Memorandum of Understanding: A MOU is a document describing a bilateral or multilateral agreement between parties.
OECD	Organization for Economic Cooperation and Development: OECD is an international organisation of 30 countries that accept the principles of representative democracy and free-market economy.
OHSAS 18001	Standard for Occupational Health and Safety Management Systems.
OPA 1990	Oil Pollution Act 1990: OPA 90 is a set of requirements and liabilities for tankers operating in US national waters.
OR	Open Registry: A flag state that allows ship owners who are not citizens of that state to register their ships in that state.
Pairwise Comparison	A process of comparing entities in pairs to judge which of each pair is preferred.
P&I Club	Protection and Indemnity Club: P&I Clubs are mutual associations of the world's shipowners, which insure marine liabilities (including environmental risks).
PRA	Probabilistic Risk Assessment Probabilistic: PRA is a systematic and comprehensive methodology to evaluate risks associated with a complex engineered technological entity (such as an airliner or a nuclear power plant).
PSC	Port State Control: PSC is the inspection of foreign ships in other national ports by PSC officers (inspectors) for the purpose of verifying that the vessel is manned and operated in compliance with applicable international law.
RI	Random Index: The comparison of the consistency of the elements of an AHP matrix with those of the same index of a randomly generated reciprocal matrix from the scale 1 to 9, with reciprocals forced.
RIA	Regulatory Implementation Assessment: RIA is a decision tool, a method of systematically and consistently examining selected potential impacts arising from government action and of communicating the information to decision-

	makers.
SIM	Safety Information Management: A set of management initiatives used to effectively produce, co-ordinate, store, retrieve and disseminate safety information from internal and external sources in order to improve the safety performance of the organisation.
SOLAS 1974	Safety of Life at Sea Convention 1974: SOLAS 1974 is an international treaty that provides regulations regarding ships safe construction and operation.
STCW 1995	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1995: STCW 1995 is an international traty that sets qualification standards for masters, officers and watch personnel on seagoing merchant ships.
TBT	Tributylin: Tributyltin compounds are a group of compounds containing the $(C_4H_9)_3Sn$ moiety, such as tributyltin hydride or tributyltin oxide.
TMSA	Tanker Management and Safety Assessment: TMSA is guide that provides a standard framework to assess a ship operator's management systems.
TOPSIS	Technique for Order Preference by Similarity to an Ideal Solution.
UN	United Nations: The UN is an international organization whose stated aims are to facilitate cooperation in international law, international security, economic development, social progress, human rights and achieving world peace.
UNCLOS 1982	United Nations Convention on the Law of the Sea 1982: UNCLOS 1982 is the international agreement that defines the rights and responsibilities of nations in their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources.

Chapter 1. Introduction

1.1 Introduction

The maritime industry is believed to be the oldest international industry in the world (King 2001). The introduction of new technologies such as satellite navigation systems (Beukers 2000) improved safety at sea in terms of navigation. Ships sail in all over the world transferring 90% of the world's commodities (Xu et al 2007) relatively cheaply and safely between countries. Such trade contributes to an increase in wealth for both countries and their citizens. However, seafarers and their ships are still exposed to many dangers such as storms and piracy (King 2005).

For centuries, the dangers of shipping were so widely accepted by people that there was not a significant attempt by many administrators to develop a regulatory regime that would improve safety at sea and trade. There were limited examples of nations that imposed regulations but such rules were restricted to ships flying that national flags. Early in the Twentieth Century, the situation changed when the world's nations realised that it would be to their benefit if they could agree to a common regulatory framework that would enhance the standards of safety at sea. The common regulatory regime became reality when in 1948 the United Nations adopted the convention that established the International Maritime Organization (IMO) (originally IMCO) (Smith 1999). To some degree the regulations imposed by the IMO established a common and acceptable foundation, and as result safety at sea was improved significantly within just a few decades. As a consequence of safer ships, there was a corresponding increase in the efficiency of sea trade.

1.2 Background Analysis

The IMO has produced numerous codes, conventions and resolutions, which are referred in this thesis as "Maritime Regulations". The aim of these maritime regulations is to ensure a high level of safety standards at sea, minimise pollution caused by ships and establish a secure environment for ships and ports. The IMO's purpose is to bring these maritime regulations to the attention of world states by organising international conferences (Kopacz et al 2001). The ultimate responsibility for adoption and enforcement of a maritime regulation depends on the world states themselves (Odeke 2005).

One might except that the majority of states would act in a responsible way and implement the IMO's maritime regulations. However, many states, often due to their lack of knowledge, fail to achieve this goal (Klikauer and Morris 2003). This stems from the rather complicated shipping industry, which consists of a large number of organizations, companies and a variety of specialized ships. These sophisticated ships, which today sail in the world's oceans, require highly educated and skillful personnel to operate, control and monitor them. It can be readily appreciated that some developing countries in need of utilizing the services of specialist ships are likely to experience difficulties in employing staff familiar with the practices associated with such ships. Furthermore this staff should be able both to comprehend and enforce the legal requirements.

It is apparent that many states lack the willingness to rigorously enforce maritime regulations (Llacer 2003). A reason for this unwillingness could be that the economies of some states are likely to be dependant on the shipping industry. Consequently, they find it necessary to provide a shield for the foreign companies based in the developing countries, which would otherwise fall foul of the criteria set by the regulations.

Such situations as referred to above have caused difficulties to the IMO in fulfilling its objective. On one hand, the standards of a proposed regulation should be minimal in order to achieve ease of ratification by a greater number of states. On the other hand, new scientific findings especially with regard to forms of pollution from ships or to design innovations lead the IMO to introduce numerous regulations. The IMO in recognising the potential risk of excessive regulatory obligations, which lack adequate enforcement, has decided to implement a new strategy targeting the worldwide implementation of the existing maritime regulations to an acceptable level (IMO 2000).

It is of utmost importance to address the risk of excessive regulations and their effect on the shipping industry. A precursory look at the conventions promulgated by the IMO reveals that most of them were introduced after 1970. After 1970, there was a plethora of regulations all needing the compliance of those within the shipping industry. Notwithstanding their justification, such regulations have imposed significant changes upon the ship operators who are a keystone within the industry. Such legislation has often been accompanied by the imposition of heavy monetary penalties and even criminal convictions.

1.3 Justification of Research

Many academics have found the maritime regulations to be an interesting field for research. Such research has focused on the impact of maritime regulations affecting safety at sea, pollution from shipboard operations, the performance and analysis of various ship related operations. Additionally some academics have explored the potentials and limitations of existing regulatory tools such as the Formal Safety Assessment (FSA) and the International Management Code for the Safe Operation of Ships and for Pollution Prevention (ISM Code 1998). To date no academic has offered a method capable of dealing with the worldwide implementation of maritime regulations issue. Moreover, there is only limited research directed at strategies or methodologies designed to improve the implementation of the maritime regulations. Nevertheless, there is a debate that a worldwide implementation could be easily achieved if the stakeholders in the shipping industry had an increased role in the regulatory process (Chantelauve 2003).

This research targets the current status and practices of the IMO for implementation of maritime regulations. The current status is investigated by analysing the process of implementing the IMO regulations and its implications into the shipping industry. Furthermore, the current implementation practices that have been adopted by the IMO are examined for possible challenges and any potential improvement. An exhaustive literature review exposes the challenges of the implementation of the maritime regulations.

In this research, a new methodology is presented regarding the implementation of the maritime regulations. The proposed methodology was designed from the viewpoint that there is a need for the IMO to adopt a strategy with regard to the implementation of the maritime regulations. The strategy should be based on the evaluation of both an existing and on a newly introduced maritime regulations implementation performance through cost benefit analysis pertinent to the stakeholders of the shipping industry. The applicability of the method is demonstrated through various case studies.

1.4 Research Aims, Objectives and Hypothesis

The primary purpose of this research is to generate a methodology capable of evaluating the implementation burden of a maritime regulation based on a cost benefit analysis. A cost benefit analysis of a maritime regulation should assess the gains and losses that will be imposed to certain stakeholders of the shipping industry. Providing such a methodology for the regulators of the shipping industry enables them with a tool capable of assessing the burdens of a maritime regulation. Then the regulators can make a decision on how they will reduce the losses of the stakeholders into an excused level.

The risk of inadequate implementation of a regulation due to its excessive costs is not exclusive to the shipping industry. Up to date, some organisations have developed guidelines on how to reduce the imposed burdens of a regulation. Additionally many governments have developed new processes, structures and tools to help them to develop new regulations, and to review existing ones (Ballantine and Devonald 2006). Some governments and administrations decided to adopt the Balanced Scorecard (BSC) to evaluate the implementation of a regulation (Phillips and Phillips 2007), (Ramos et al 2007). The BSC is a comprehensive simple performance measurement tool that a regulator can use in order to assess the impact of a regulation to a stakeholder's commercial activities such as costs, profits and human resources availability. Furthermore, a system of many BSCs for a group of stakeholders can be used to evaluate the imposed burdens of a regulation to that group. The group of stakeholders can be an entire industry. Therefore, in this research, it is suggested that the BSC is a potential tool to evaluate the implementation burdens of a maritime regulation in the shipping industry.

The BSC can be used for a cost benefit analysis of the shipping industry and its stakeholders. However, in the implementation of a maritime regulation the contribution of each stakeholder may have a different weight. Consequently, the weighting of each stakeholder should be determined. There are many available methods with regard to the weighting of elements of a given problem however, the Analytic Hierarchy Process (AHP) has an advantage over to other methods due its simplicity and its ability to rank parts of a multi-criteria problem into a hierarchical structure (Chan 2006). The AHP is significantly improved when it is used with a Fuzzy Scale for measuring weight criteria in hierarchical structures (Cheng 1996).

In this research, the potential of a maritime regulation to be implemented worldwide in a short period is defined as its implementation performance. This implementation performance of a regulation can be evaluated by assessing its implementation costs and benefits. For instance, an evaluation of the implementation performance of the ISPS Code should be indicated very high. The evaluation should include implementation costs such as training, equipment maintenance and additional workload to seafarer. On the other hand, the benefits from the code are minimising the security threat of ships and ports. These security threats could lead to loss of human lives and reduction of seaborne trade. Obviously the benefits are considerable more important than the costs.

To achieve the main aim of this research is to introduce a methodology regarding performance-based evaluation of a maritime regulation by assessing the costs and benefits of a maritime regulation. A main hypothesis in this research is that the stakeholders of the shipping industry will more easily implement a maritime regulation that offers significant benefits while at the same time requiring the minimum costs for its implementation. Therefore, the proposed performance-based methodology includes the commercial activities of the stakeholders. The innovative idea of this methodology is that the implementation of a regulation may be more effective if it is possible to evaluate the implementation performance of a maritime regulation.

The methodology is devised so as to be applicable in a generic form so including the shipping industry in its entirety. Special consideration is given to the ability of a small stakeholder to implement a maritime regulation because it is suggested in this research that the shipping industry should be open to small stakeholders. To achieve a detailed evaluation of the shipping industry the methodology is divided in two stages, one for an implementation evaluation of the shipping industry and the other for a detailed evaluation of a stakeholder. For each stage of the methodology, a tool is introduced in order to evaluate the implementation performance of a stakeholder either individually or as a part of the shipping industry.

The introduced methodology should address various important issues such as rationality of data collection, their utilisation and the production of the tools. By adopting this approach the methodology will satisfy the needs of a comprehensive performance measurement system applicable for any stakeholder. To fulfil the above mentioned issues a number of subsidiary objectives need to be met:

1. To create a system of Balanced Scorecards (BSCs) that will include the commercial activities of every stakeholder.
2. To evaluate the degree of contribution of each stakeholder to the regulation implementation by using experts' judgements.
3. To evaluate the experts' judgements by using Fuzzy Set theory.
4. To make pairwise comparisons between the stakeholders in order to rank them according to their weight in the regulation implementation process.
5. To develop and demonstrate the applicability of the proposed tools through case studies.

1.5 The Limitations of the Research

The procedure for the implementation of maritime regulations is a complex one. The maritime regulations already drafted and enacted are numerous. In addition, the maritime regulations are drafted in a variety of formats such as codes, conventions, resolutions and circulars. Hence, an attempt to investigate the implementation procedure poses difficulties. These difficulties are exacerbated mainly due to the many stakeholders in the shipping industry together with the industry's international character, the large number of regulations and the lack of previous related research. Thus, in this research, the definition of a maritime regulation is narrowed to a single requirement of an IMO convention. The scope of this selection is to study the effect and the difficulties experienced by the shipping industry's stakeholders in managing a small change to an already existing regulatory regime.

A further challenge in this research is the high number of stakeholders in the industry and also the variety of activities covered by maritime regulations. The approach that is followed is that the stakeholders can be grouped according to their interests. From each group a representative stakeholder can be chosen as a sample of the industry. Thereafter the sample can be used to investigate the distribution of various costs and benefits in the shipping industry. The terms "costs" and "benefits" are used in a wide sense in order to extend the meaning of the possible gains and losses to a stakeholder from the implementation of a regulation and so include non financial issues such as reputation, innovation and employees skills.

The subject of this research has not previously been approached in a similar manner. This makes it difficult to collect data from past experience since most researchers have focused either on the effect of a regulation in a localised geographical region, or to specific types of ships or to a specific group of stakeholders. However, the majority of such research can provide valuable information on the implementation of the maritime regulations. Furthermore, it is necessary to investigate approaches to the management to the regulations of other industries such as nuclear, chemical process and aviation. These approaches are examined for their applicability to the maritime industry.

Considering the above limitations, it is nevertheless possible to design a method that will estimate the performance of a maritime regulation. This method will be capable of contributing positively to the implementation of maritime regulation by examining the difficulties of the stakeholders to comply with a regulation. In addition, any excessive burden on a stakeholder would be a reliable indication that this stakeholder will either probably try to limit this burden or to avoid it.

1.6 Research Methodology

The research methodology that is used to fulfil the aims and objectives of this research is shown graphically in Figure 1.1. The stages of the research are as below:

1. Literature review.
2. Development of a proposed methodology.
3. Demonstration of the proposed methodology.
4. Implementation of the proposed methodology.

A literature review is carried out to assess challenges in the implementation of the IMO regulations. Due to lack of previous research on a similar topic, the literature review consists of four interactive parts. The first one analyses the process of implementing maritime regulations and assess the challenges of this process. The second part investigates the success of the current regulatory system from accidents point of view. The third party of the literature review compares the shipping industry with other high-risk industries, which operate in strict regulatory environments. This comparison extends as to how governments deal with excessive regulations. The fourth part of literature review focuses on the potentials and challenges of current practices applicable to the shipping industry.

The next stage of the research is the development of a proposed methodology. In this stage a study of sound methods is conducted. A methodology is then proposed which is a combination of the above methods in order to minimize the limitations, which might otherwise arise. The proposed methodology, which is a performance management system, lists various measures that can be used to monitor the implementation performance of a regulation. These measures are analysed and adopted for a group of representative stakeholders.

The proposed methodology consists of many steps and takes into account many stakeholders in the shipping industry. Therefore, it is appropriate to carry out a case study in order to demonstrate as to how it can be used. For this reason two case studies are used, one for the shipping industry and the other for a ship operator as an example of a stakeholder.

After the demonstration of the proposed methodology two surveys are carried out to implement the proposed methodology. These surveys are used for two purposes. First, to validate the methodology by industrial experts. Secondly, to investigate the costs and benefits of the stakeholders generated by the implementation of a regulation.

1.7 Structure of Thesis

To achieve the aims and objectives of this research the thesis is structured in a rational order to demonstrate the applicability of the proposed methodology capable of dealing with the regulatory issue. The thesis consists of the following main parts:

1. An investigation into the challenges posed by maritime regulations, and also a comparison with the challenges faced by other industries.
2. Development of a generic methodology applicable to the shipping industry.
3. Development of a performance management tool capable of measuring the implementation of a regulation within the shipping industry.
4. Development of a performance management tool capable of measuring the implementation of a regulation by a ship operator.
5. Implementation and validation of the above tools.
6. Conclusions.

A diagram of this research structure is shown in Figure 1.1. This thesis consists of ten chapters, the contents of which are briefly described below.

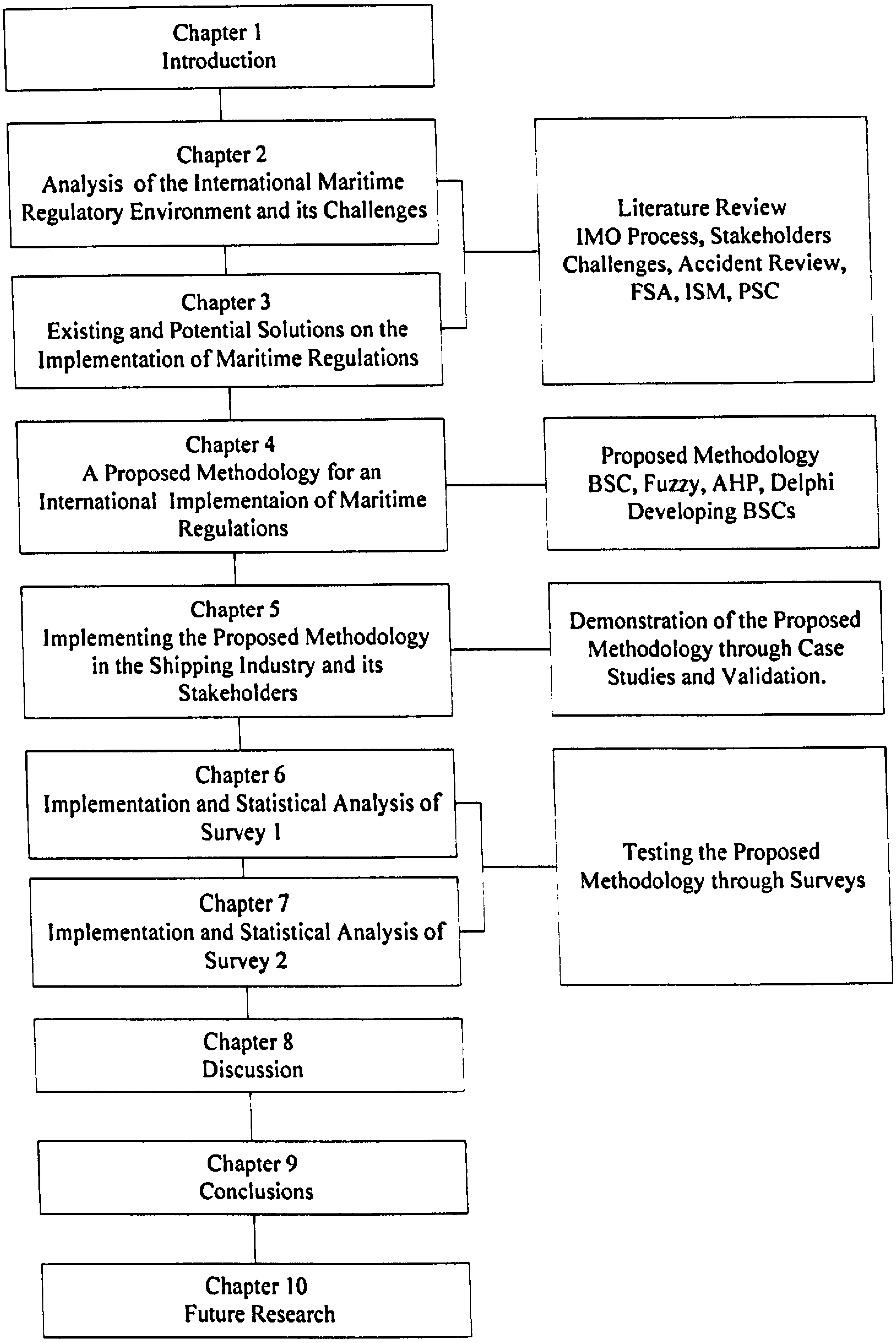

Fig. 1.1. The Structure of the Research

Chapter 1. Introduction

A generic introduction about this research is presented. Key issues such as a proposed methodology and research justification are highlighted. Furthermore, the structure of the thesis is presented.

Chapter 2. The maritime regulatory environment

In this chapter the process of the implementing an international maritime regulation is described. This process is assessed to identify potential challenges of various stakeholders. The efficiency of maritime regulations is discussed in conjunction with the accidents that occur in the shipping industry.

Chapter 3. Investigation of the impact of maritime regulations

In this chapter, various methods and tools introduced by the IMO to improve the regulatory procedure are described and analysed for their efficiency. Furthermore, comparisons are carried out between the shipping industry and other high-risk industries such as nuclear plants, aviation and chemical process, in terms of their regulatory regimes.

Chapter 4. A proposed methodology for the implementation of maritime regulations

In this chapter, a new methodology is proposed which can be used to improve the implementation procedures of the IMO and other stakeholders by targeting a worldwide implementation of the maritime regulations. The proposed methodology is analysed and discussed as for its potentials and limitations.

Chapter 5. Implementing the proposed methodology for the shipping industry

This chapter presents consecutive case studies assessing the implementation of maritime regulations in the shipping industry. The results are then discussed and compared with what other researchers have found.

Chapter 6. Implementation and statistical analysis of Survey 1

In this chapter, a survey is carried out to test the first part of the methodology. Questionnaires are distributed to several industrial experts and they were requested to evaluate the importance of various stakeholders in the shipping industry. The outcome of this survey is used to analyse trends of the shipping industry and rank the importance of each stakeholder.

Chapter 7. Implementation and statistical analysis of Survey 2

An additional survey is carried out as the second part of the proposed methodology and its results are discussed and analysed in this chapter. This survey is used in order to implement the ship operator tool as proposed in the methodology. In this survey ship operators are requested to evaluate their implementation performance with regard to a certain regulation. The challenges of a ship operator to implement a maritime regulation are then analysed and discussed.

Chapter 8. Discussion

This chapter presents the use and limitation of the proposed tools. Additionally it presents the contributions and limitations of this research.

Chapter 9. Conclusions

This chapter presents the conclusions of this research. These conclusions include comments regarding the outcomes of the research and how the initial aim and objectives were met.

Chapter 10. Future Research

In this chapter, some recommendations for future research are proposed.

References – References related to the research are presented in this section.

Appendices - The section provides relevant information and data of the research.

Chapter 2. Analysis of the Maritime Regulatory Environment

2.1 Introduction

The process of implementing a maritime regulation is intrinsically complicated and furthermore it consists of various stages involving a large number of states, organisations and companies. Therefore, the investigation of the implementation process of a maritime regulation is a fundamental aspect of this research in order to assess which steps of the process present the most obstacles.

2.2 The IMO Regulatory Process

The implementation process of a newly introduced maritime regulation is achieved by adherence to the following seven main steps, which are described briefly in the subsequent paragraphs of this section (IMO 1975), (UNCLOS 1982):

1. The appropriate IMO committee drafts a regulation (Stenman 2005).
2. The IMO submits the regulation to its member states at a conference (IMO 2000).
3. A number of states adopt the proposed regulation (IMO 2000).
4. Flag states incorporate the regulation into their national laws and make it compulsory for their ships (Odeke 2005).
5. Coastal states also make the regulation compulsory for the ships visiting their ports (Devine 2000).
6. Ship operators implement the regulation requirements into their systems (Mitroussi 2004b).
7. The crew members conform with the regulation (Talley et al 2005a).

In the implementation procedure, there are many other parties which participate in the maritime industry. These parties are known as private stakeholders and they are not directly involved in the IMO process by voting as member states. However, they can contribute positively to the maritime regulation implementation by excluding the substandard ships and their operators from the market. Lately there is a growing demand for more involvement of the private stakeholders in the procedure of maritime regulations implementation (Lambrou et al 2008), (Paixao and Marlow 2001), (Bennett 2000a). Their contribution in the maritime regulation process is investigated separately apart from the seven steps of the implement process.

2.2.1 The Appropriate IMO Committee Drafts a Regulation

When there is a need to improve an area in the shipping industry the IMO will develop and propose a maritime regulation. Any regulation should be drafted by a group of people who have a high level of expertise in the appropriate matter. Therefore, the IMO is organised into departments consisting of an Assembly, a Council, a Maritime Safety Committee (MSC), a Legal Committee, a Marine Environment Protection Committee (MEPC), a Technical Cooperation Committee, a Facilitation Committee and a Secretariat (Stenman 2005). There are also a number of sub-committees supporting the work of main Committees. Every state is participating equally in these Committees as a member with one vote (IMO 2000). The structure of the IMO is organised into a hierarchy where the Assembly is in the highest position and has a session every two years. The Council is elected by the Assembly, which is the IMO's supreme governing body and is responsible for supervising the work of the organization. It is constituted from representatives of forty states where ten are those with the largest interest in providing international services, with further ten having the largest interest in international seaborne trade (IMO 1977). The remaining twenty representative states do not belong to the above categories but represent major geographical areas of the world. Committees, which consist of all member states have a meeting at least every year, and draft regulations in the form of conventions, codes, rules and recommendations.

2.2.2 The IMO Submits the Regulation to its Member States in a Conference

It is clearly stated in Article, 2b of the IMO founding convention that the purpose of the IMO is to draft regulations but not to implement them. Therefore, each appropriate committee agrees the formal procedure for a regulation to be implemented. The Council or the Assembly submits the draft to a conference where all the United Nation (UN) member states are invited even if they are not IMO members (IMO 2000). The conference adopts a final text, which is submitted to governments for ratification. The content of a convention is binding on the states that have signed it, while codes and recommendations are optional. Yet, the signatory states adopt them by incorporating the full text or part of a convention, code or recommendation to their national law (Talley et al 2005a). The formal adoption of a convention can take several years. Each convention describes the procedure to be followed before the convention enters into force.

2.2.3 A Number of States Adopt the Proposed Regulation

Convincing member states to adopt regulations is not always an easy task. States have different interests and very often there is a conflict of interest. Evidence of such conflicts can be found in the unwillingness of states to sign or enforce a convention. Moreover, a convention, after it is enforced, often needs to be amended to reflect changes in technology and techniques of the shipping industry.

In the early days of the IMO the procedure to amend a convention required the amendment to be accepted by two thirds of the conventions contracting states. This requirement was not achieved very often and as a result some amendments were never adopted (IMO 2000). Therefore, the IMO introduced the concept of the tacit acceptance. This provides that amendments will enter into force by a specific date unless objections are raised. Under the new procedure, the obstacles for a convention to be amended were minimized since a state must raise an objection to the proposed changes.

2.2.4 Flags States Incorporate the Regulation to their National Law and Make it Obligatory for their Ships

For many centuries, a principle that prevails at sea is that every merchant ship should fly a flag of a state (Llacer 2003). The state, known as the flag state, is the only authority responsible for enforcing safety standards to ships entitled to fly its flag on the high seas (Alderton and Winchester 2002a). By adopting an IMO convention, a flag state must enforce the convention's requirements to its registered ships (Kovats 2006). In Article 91 of the United Nations Convention on the Law of the Sea (UNCLOS 1982) it is emphasized the great weight to the idea of a 'genuine link' between the ship and the flag of the ship (Alderton and Winchester 2002a). Furthermore, in Section 1 of Part VII of UNCLOS 1982 it is stated that a flag state is obligated to ensure that its ships are operated under safety standards (Odeke 2005). A common procedure for a flag state to meet this obligation is to inspect its ships by a flag inspector at regular intervals.

It is not within the scope of this research to analyse the UNCLOS 1982 requirements and objectives. It is only mentioned as a reference as to why a flag state is legally nominated to have the primary control of a ship that is flying its flag. The harmony between the IMO and UNCLOS 1982 objectives is not in doubt (IMO 2007).

2.2.5 The Coastal States Make the Regulation Compulsory for the Ships Visiting their Ports

Many states have sea territories and benefit from various activities related to the sea such as seaborne trade, fishing and tourism. These states are known as coastal states. Although their coasts and ports are engaged to sea trade, they may not necessarily control a significant number of ships under their flags. However, their power in the IMO is significant and affects maritime regulations since they can sustain damages to their seas by a foreign ship.

Every ship is free to navigate in the territorial sea of a coastal state under minimal requirements, which are laid in UNCLOS 1982 and referred as "Innocent Passage" (Keyuan 2002). Under UNCLOS 1982 there are three recognized areas of jurisdiction of a coastal state, which are the ports, the territorial sea and the Exclusive Economic Zone (EEZ) (Perry 2006). According to Article 218 of UNCLOS 1982 from the above areas a coastal state has the ability to inspect and find substandard ships, without affecting the freedom of high seas, only when a ship is in one of its port (Devine 2000). The procedure of ships inspections at ports is known as "Port State Control" (PSC).

2.2.6 Ship Operators Implement the Regulation Requirements into their Management Systems

A most important stakeholder affected by the maritime regulations is the ship operator. A ship operator may own ships or manage a fleet for shipowners (Klikauer and Morris 2003). Ship operators must operate their ships under a complex maritime regulatory regime, which consists of regulations posted by flag states, coastal states, and the IMO (Mitroussi 2004b), (Alderton and Winchester 2002a). Every ship that a company operates must comply with the legislation of a ship's flag state, the IMO and the coastal states that it visits. The issue is more complicated when a company is managing several ships registered in different flags, and consequently it has to comply with all different administrations. Ships must also comply with the regulations of the coastal states whose ports they call. Hence, it is very important for a ship operator to be informed for all maritime regulations and be able to comply with them.

2.2.7 The Crew Members Conform with the Regulation

The final stage of the implementation process is crew members to conform with the IMO regulations. There is a great deal of discussion, with regard to the ability of crew members to conform with maritime regulations. These discussions are mainly focused on training, costs, quality and supply of seamen (Vanem et al 2008a), (Hetherington et al 2006), (Li and Wonham 1999), (Klikauer and Morris 2003). The role of crew members in the implementation of maritime regulations has been well considered by the IMO since most of the accidents are caused by human errors (Talley et al 2005a), (Wang 2006). The revised International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1995 (STCW 1995) and the International Safety Management Code for the Safe Operation of Ships and for Pollution Prevention 1998 (ISM Code) are two steps towards the increased quality of seamen (Sambracos and Tsiaparikou 2001).

2.2.8 The Involvement of Private Stakeholders in the Regulations Implementation

Apart from states, which have a fundamental role in enforcing maritime regulations, the shipping industry also consists of private stakeholders with a great interest in ship safety. Any new regulation, which has an effect on either ship operation or safety standards, will affect the private stakeholders. Examples of such private stakeholders are insurers, P&I Clubs, classification societies, charterers, cargo owners, consultants and shipyards (Trucco et al 2008), (Chantelauve 2003). Private stakeholders play an important role in the implementation of a regulation by adopting existing maritime regulations as minimum requirements of safety (Mason 2003). Such a practice can improve maritime safety and environmental performance by excluding substandard ships from the sea trade.

In recent years, there has been an attempt by some states to involve the private stakeholders in maritime regulations. The European Commission is attempting to enrol as many industry stakeholders as possible in its "Quality Shipping Campaign" to influence regulatory standards, (Paixao and Marlow 2001). It should be stressed that the interest of private stakeholders on safety at sea is much narrower than those of states since they have conflicts of interests in controlling clients versus retaining their market share. Insurers for instance, seeking to manage their own financial risks, require risks to be justified by statistics before they will insure them. Moreover, P&I Clubs aim to act in the interests of all their shipowning members, and stress the importance of 'maintaining mutuality' between risks (Bennett 2000a).

2.3 Challenges to the Implementation of Current Maritime Regulations

Although there are many maritime regulations covering a range of activities in shipping, there is a lack of enforcement to an adequate worldwide level (IMO 2000). Consequently, a ship operator can choose to register his ships under various flags depending on the level of regulatory enforcement with which they want to comply (Alderton and Winchester 2002a). Moreover, he may choose to operate his ships under regimes with inadequate regulatory enforcement. This situation has raised great concern and has been studied from different viewpoints. Gathering all these viewpoints the challenges regarding the implementation of maritime regulations can be summarised as:

1. The IMO challenges to implement maritime regulations worldwide to all ships.
2. The flag states challenges to implement maritime regulations to their registered ships.
3. The coastal states challenge to implement maritime regulations to foreign ships visiting their coasts.
4. The ship operators challenge to implement maritime regulations to the ships they operate.
5. The private stakeholders challenge to implement maritime regulations to the ships they have an interest in.

2.3.1 The IMO Challenges to Implement Maritime Regulations Worldwide to all Ships

The freedom of states to selectively adopt maritime regulations has created sets of various regulatory regimes among the states. At one end, there are states that adopt all the IMO regulations and often make them stricter in their national law (Hosseus and Pal 1997). At the other end, some states fail to enforce adequately the regulations due to lack of knowledge or unwillingness (Alderton and Winchester 2002a), (Llacer 2003). The variety of regulatory regimes has created deep concern as to the efficiency of the IMO among its members. Some states occasionally feel that the current IMO procedures are not effective enough and thus often they enforce their own regulations with applicability to all foreign ships entering into their jurisdictions. One notable case is the enforcement of the Oil Pollution Act 1990 (OPA 1990) by the USA within its jurisdiction so ignoring any relevant IMO procedures (Kim 2003). Every coastal state has the right and obligation to protect its natural sea resources from any environmental threat. However, it should be stressed that the practice of unilateral actions from states, such as USA's OPA 1990, may depreciate the IMO as being the leading regulatory authority. Consequently, there is the possibility that the shipping industry will become confused by an overly regulatory regime.

2.3.2 The Flag States Challenges to Implement Maritime Regulations to their Registered Ships

A flag state may choose not to adopt a maritime regulation if it is in conflict with its interests (Kim 2003). Some flag states are working hard in respect of their ships' safety and frequently they develop rigorous regulations leading sometimes to exaggerated and complicated legislation (Urk and Vries 2000). Some other flag states simple follow the IMO's regulations whenever they come into force in order to keep pace with international standards. However, many states are unable to control the ships that are flying their flags (Alderton and Winchester 2002b). These states are known as "Open Registries" (OR) or as "Flags of Convenience"(FOC). Their inability to control their ships is due either to lack of knowledge or to their unwillingness to comply with the maritime regulations. To address the knowledge aspect the IMO has launched a technical cooperation scheme to assist states to implement more effectively maritime regulations (IMO 2003).

A significant number of FOCs take advantage of the vagueness of UNCLOS 1982 articles by promoting less strict legislative compliance (Li and Wonham 1999). Furthermore, they offer advantageous regimes by requiring in some cases only an annual registration fee (Odeke 2005). The tax haven and lack of maritime regulation enforcement offered by various FOCs are very competitive tools in attracting a significant number of ships to their registries. It can be assumed that there is a high degree of competition among FOCs. A FOC's competitiveness against other FOCs depends on the continued and anticipated maintenance of a light regulatory environment (Alderton and Winchester 2002a). Consequently, every internal attempt from a FOC to adequately enforce a new regulation is a threat to the environment of the FOC. The success of a FOC is a permit for a continuous lax regulatory environment for ship operators (Alderton and Winchester 2002a).

The growth of FOCs in terms of ships tonnage is significant. In the last decade FOCs controlled forty-four percent of the global tonnage (Li and Wonham 1999). This high percentage was slightly increased to forty-six percent in 2003 (UNCTAD 2004), but then slightly reduced to forty one percent in 2006 (IMO 2006). It is noteworthy that during the same period Malta and Cyprus, two traditionally recognised as FOCs, joined the European Union (EU) and were removed from PSC MOUs black lists (Equasis 2005). The deletion of these two traditionally recognised FOCs from black lists could be due to the fact that both countries had to harmonise their laws with the EU high requirements or that they received a more favoured treatment from EU PSC. However, in the three year period from 2003 to 2006 Cyprus lost forty per cent of her tonnage and Malta lost forty-four per cent respectively. This could be a clear indication of the consequences to flag states when implementation of maritime regulations becomes more rigorous.

2.3.3 The Coastal States Challenges to Implement Maritime Regulations to Foreign Ships Visiting their Coasts

A coastal state is vulnerable to risks of sea trade threats such as oil and air emissions pollution, however its jurisdiction over foreign ships is limited. Therefore, a foreign substandard ship is free to sail within the sea territory of a coastal state and so possible to cause damage to the environment. Lack of appropriate actions against substandard ships by a variety of flag states has led coastal states to be cautious with certain flags (Keselj 1999). Through PSC MOUs coastal states are cooperating in order to monitor the quality of the ships entering their jurisdiction.

In the aftermath of *Prestige* accident, there is a trend by some countries to impose stricter controls on transient oil tankers through their sea territories. Spain, France, Portugal, Belgium and the UK submitted a petition to the IMO to declare virtually their entire EEZs to be "particularly sensitive sea areas", which would be completely off-limits for single hulled oil tankers and other cargo vessels transporting dangerous cargoes (Dyke 2005). Although the IMO has not yet approved this initiative, this effort by these five maritime countries to protect their own coastal resources provides strong support for their view that it is legitimate to restrict maritime freedom in order to protect the natural resources within the EEZ limits, which is a distance of 200 nautical miles from their coast (Dyke 2005). If similar initiatives are approved then there is a risk to limit significantly the old principle of free navigation at sea.

2.3.4 The Ship Operators' Challenges to Implement Maritime Regulations to the Ships that they Operate

The definition of a ship operator in this research is the person, or company, who has the responsibility for the operation of its own ships or manages ships of other owners. Typical examples of a ship operator would be a shipowner, ship manager or bareboat charterer. The aim of a ship operator is not different from any other company in business world, which is to ensure that his business is profitable. Profit will necessitate the long-term business survival of the company especially during depressed market cycles. It should be emphasized that a stable reasonable regulatory environment is an advantage for a ship operator (Brooks 2002).

A ship operator faces many challenges during his commercial activities. The ship operator makes a profit by hiring the space of each ship that he operates to transfer cargo for a voyage or a specific period (Li and Cullinane 2003). Various regulated issues such as speed, seaworthiness, effective equipment and manning are of primary importance for the ship operator. Furthermore, ships visit ports of different states on a regular basis and consequently they are subject to different regulatory regimes. In addition, some states have extended their jurisdiction through their EEZ. Hence, a ship sailing in the area of EEZ, even if it does not intend to call a port of that state may, have to comply with some restrictions (Keyuan 2002). It should be stressed that the coastal states will expect a ship entering its territory to comply with its unique requirements (Paris MOU 2006).

Compliance of ships with all national and international requirements is very frequently examined through a complicated inspection programme (Mokashi et al 2002). Flag state inspections are carried out on an annual basis to ensure safety standards that the flag state has adopted. This is a more complicated issue since the ships of a ship operator may be of different types and be registered on various flag states and classification societies. The classification societies' surveyors through a specific schedule determined by the IMO conventions inspect ships in order to issue certificates of compliance with certain IMO requirements e.g. Load Line on behalf of a flag state (Bennett 2001). PSC officers inspect ships to verify their compliance with regulations that apply internationally by the IMO and those nationally applicable at that port of call. Furthermore, independent surveyors will often inspect ships on behalf of third parties such as P&I Clubs, insurance and charterers.

A further challenge for the ship operator is that the shipping industry suffers from a very negative public opinion, which in the case of an accident will press governments and authorities for immediate justice against the ship operator (Sampson 2004), (Chantelauve 2003). An involvement of a ship operator's ship in an accident may result in bad reputation for his company, heavy finance consequences, losses of lives, and even prison convictions for his employees (Chen 2000).

In order to comply with all the maritime regulations a ship operator must find the appropriate human resources to fulfil positions onboard his ships and ashore. Availability and quality of human resources are the cornerstones for a rational management system of a company. However, due to changes in crew labour resources, it is common for ships to be manned by crew members from the Far East when their company is based in Europe. A ship registered under a FOC may have limited restrictions regarding manning such as crew nationality and manpower. As a result, many companies operate their ships with cheap labour from developing countries overlooking their lack of skills (Klikauer and Morris 2003). Ship crew members should be considered as the most vital guards in the process of implementing a maritime regulation. Adequate human resources should also be ashore to implement regulations and to provide guidance and assistance to crew members on ships. Demand for human resources ashore is sometimes generated by regulations to cover specific position as "Designated Person Ashore" and "Company Security Officer" required by the ISM Code (IMO 1993) and the International Code for the Security of Ships and of Port Facilities (ISPS code), (IMO 2002) respectively.

There is considerable evidence that the choice of a shipowning company in giving the management of its fleet to an independent third party ship management company may be related to the growth of maritime regulations (Mitrousi 2004a). An independent management company with qualified personnel and experience in the shipping industry can be an attractive option for a shipowner. The use of third-party management option offers a flexibility towards financial and legislation regimes to shipowner since it may be difficult to prove privity of shipowner for the seaworthy condition of his ship (Mason 2003).

2.3.5 The Private Stakeholders' Challenges to Implement Maritime Regulations to the Ships they Have an Interest in

Aven and Korte (2003), and Chantelauve (2003) have discussed the need for involvement of private stakeholders as active players in the regulation implementation process. There are a number of private companies such as classification societies, charterers, cargo owners, consultants and shipyards, which are not directly affected by maritime regulations (OECD 2001). However, the regulations may affect the market by changing the number of ships in service or the cost of their operation (OECD 1998).

Classification societies are companies that undertake inspections of ships in order to certify their standards. Classification inspections are twofold, one to verify that their registered ships maintain standards according to its classification society's rules and the other to issue a certificate on behalf of a flag state (Vorbach 2001). Classification societies have a long history of providing services to the shipping industry, however some of them do not have a good reputation due to inadequate standards of their ships (Boisson 1994). The foundation of International Association of Classification

Societies (IACS), aims to set similar standards among its members. However, there are still many non-IACS classification societies, which are considered by coastal states as substandard (Equasis 2005). It should be stressed that despite the variation of standards among classification societies a ship is compulsory to be classed as it is stated in regulation 3-1 of Safety of Life at Sea Convention 1974 (SOLAS 1974) Chapter II-1 (IACS 2007).

Insurers are private companies that undertake to indemnify any party that has interest in a ship's voyage such as shipowners, cargo owners, mortgages and crew. The insurers earn a premium of the insured party. A fundamental principle for a ship to be insured is that it complies with international maritime standards (Bennett 2000b). Failure to comply may result in loss of indemnification. However, in a case of a ship's total loss such as foundering it may be difficult to verify its seaworthy condition due to lack of evidence. Consequently, insurers must have confidence in maritime regulations and their effective implementation in the industry (Bennett 2000b).

Protection and Indemnity Clubs (P&I Clubs) are mutual societies of shipowners that have mutual indemnification against third party liabilities (Bennett 2001). Similar to other insurers P&I Clubs are immediately concerned that their ships sail under international standards. Contrary to insurers, which are limited to the value of ship or cargo, P&I Clubs are exposed to higher claims. Proved privity of shipowner for unseaworthy condition of his ship is a sufficient element that is highly possible to expose his club to unlimited claims from any party affected by the ship's accident (Mason 2003).

2.4 Regulatory Failure Analysis

The international regulatory regime has been examined in the previous sections as to its complexity. However, it is argued that the increasing number of regulations does not improve ships safety significantly. Therefore, in the following sections there is an investigation as to the effect of a regulation on ship safety, pollution and casualties near coasts.

2.4.1 Accident Review Regarding Ship Safety

One way to review the results of regulations regarding ship safety is through a review of accidents. Many researchers have investigated the causation of accidents at sea. Some of these researchers link the accidents with some flag states inability to enforce safety standards at their ships, human error, exclusion of coast trade ships from IMO requirements and insufficient regulations. Additionally, Li and Whonanam (2001) concluded that the implementation of the IMO regulations is inadequate due to the growth of FOCs, their applicability to ships of more than 500 g.t., and ships normally engaged on international voyages. Ships, especially coastal ferries in some developing nations, may not be properly registered and named, and ship disasters of such coastal ferries are not widely known or brought to the attention of the IMO (Li and Whonanam 2001). There is also an opinion that the regime is reactive and does not prevent the future occurrence of marine incidents by anticipating possible failure scenarios (Pomeroy and Jones 2006). For instance, the evolution of the EU maritime safety policy has been developed in the aftermath of major accidents (Pallis 2006).

A noteworthy area of research is bulk carriers losses during the last twenty years as a consequence of the inadequate regulatory environment on which they operated. A study based on the loss of 125 bulk carriers often as a consequence of structural failure, during the 36-year period 1963–1996 (Roberts and Marlow 2002) identified a correlation between a bulk carrier's safety and its flag. More precisely, it was found that bulk carriers registered with many of the FOCs and with other states, which are not members of Organization for Economic Cooperation and Development (OECD), were more likely to founder than those in OECD fleets. However, other research studies conclude that in terms of safety some FOCs have very good records (Llacer 2003). Yet, Alderton and Winchester (2002a) observed that there were differences between casualty rates for FOC, second/international register and national flagged ships, but there are also such differences within the FOC group itself. In addition, Roberts and Marlow (2002) added that the newer entrants to the FOC market are much more likely to have poorer safety records than their more established competitors.

The IMO reaction in respect to bulk carrier casualties was to develop regulations, which recommended an age limit of ships service, stricter survey programmes and introduced guidelines for cargo handling operations (Li and Wonham 2001). However, despite the IMO regulations and guidelines, bulk carriers continue to be at risk of suffering structural failure. In particular, concern continues to centre on theoretical weaknesses in the design of bulk carriers and their ability to withstand abnormal waves (Roberts and Marlow 2002). Roberts and Marlow (2002) identified the age of a ship as risk factor. However, they did not explain the loss of many new ships and why ships aged more than twenty years had fewer casualties than ships aged fifteen to nineteen years old. The case of the bulk carrier losses should be considered as an example of inadequate design of regulations by the IMO, which allowed structural defective ships to sail.

Many researchers have identified that the evaluation of ship casualties is difficult due to inadequate records. The available records are based on total loss casualties. However older ships are more likely to be written off as constructive total losses following damages to the ship and scrapped, as compared to newer ships where there is a greater incentive to effect repairs and return the ship to service (Roberts and Marlow 2002). In addition, the IMO has not had a global detailed statistical data (Campa Portela 2005), (IMO 2006).

The applicability of maritime regulations to other types of ships such as passenger ships (Lois et al 2004), (Kim 2005) and oil carrier ships (Verntikos and Psaraftis 2004), (Llacer 2003) has also been investigated by few researchers. A study concerned with passenger evacuation analysis in passenger ships noted that the IMO requirements are minimum (Vanem and Skjong 2006). The same study also suggested that in the current regime it is not sufficient to meet certain performance criteria by the IMO without an adequate study of their impact on the total safety of the ship.

The main cause of accidents is human error, with 80% of accidents being so attributed (Talley et al 2005a). However, it is not clear as to whether the human factor can be traced back to errors in design, construction or routine maintenance (Goulielmos and Tzanetos 1997). The accident analysis of human error onboard has lately been connected to the insufficient English language skills of seamen (Yercan et al 2005).

Harrald et al (1998) described an incident as a triggering event, such as a human error or a mechanical failure that creates an unsafe condition that may result in an accident. Toffoli et al (2006) noted that although many incidents may be related to human errors, accidents still occur due to unexpected and dangerous sea states, which can result in an inability to keep the ship under proper control.

2.4.2 Accident Review Regarding Pollution

The pollution prevention from ships is a major issue for the IMO. The "International Convention for the Prevention of Pollution from Ships", 1973, as modified by the Protocol of 1978 (MARPOL 73/78) is an attempt to focus on main issues that harm the environment. It should be stressed that the IMO must coordinate with other organizations to fulfill the objectives of international environmental agreements such as the Kyoto Protocol in 1997 despite the costs that are imposed upon the shipping industry (Bode et al 2001).

A ship can pollute during its normal operation or in case of an incident such as oil discharge from a tanker's cargo tanks, the bunkers of a cargo ship or the discharge of any other hazardous cargo. Pollution from routine operation of a ship may include the transfer of alien species through ballast, release of harmful substances from ships coating, air emissions and ships garbage (Ringbom 1999). All these pollution threats are subject to maritime regulations, which cover many additional operation requirements such as sewage treatment, reception facilities, and combating of spills in both coastal areas and deep sea (Kopacz et al 2001).

Many times new technologies are developed to satisfy the IMO regulation requirements such as oil pollution mitigation (Verntikos and Psaraftis 2004). However, it should be underlined that due to innovation in ship design ship's safety was improved before the introduction of any IMO requirement. Verntikos and Psaraftis (2004) also pointed out that it is difficult to totally eliminate the risk of oil pollution, hence actions should be considered in order to improve spill response plans. According to the data of International Tanker Owners Pollution Federation Limited (ITOPF) oil spills of less than 7 tons account for 92% of all oil spills (ITOPF 2006).

By examining the ITOPF data two very important conclusions are noted. Firstly *Erika* (1999) and *Exxon Valdez* (1989) accidents caused more regulatory reaction by enforcing double hull construction for tanker ships than *Atlantic Empress* collision (1979) and *ABT Summer* (1991). However the former two incidents resulted in a sum of 83 thousand tons of oil spill when the last two caused 245 thousand tons of oil spill. Secondly the data were collected by various sources, which make it difficult to measure the quantity of oil that is discharged intentionally or accidentally. It is noteworthy that unilateral actions may have better results than the agreements of the IMO. Llacer (2003) stated that some unilateral actions such as OPA 1990 of USA, and "Erika I" and "Erika II" packages of European Union contributed to a cut-down in marine pollution over the last 12 years although maritime accidents still occur.

The various oil pollution and environmental regulations have generated a great deal of criticism regarding the criminal liability of seafarers, which can arise as a result of pollution incidents. These regulations can impose strict liability on the shipowner and may require compulsory insurance (Ringbom 2004). Sampson (2004) also found that the penalties to ship operators by oil spill are significantly higher compared to a total loss of a bulk carrier, which sometimes is unpublished. However, strict liability regimes may discourage a company to report an incident if it is not detected by authorities (Ball 1999). The lack of adequate port facilities for the discharge of oily water together with expensive charges may also lead companies to follow illegal practices (Wonham 1998). Moreover, Viladrich-Grau (2003) stated that it is difficult to distinguish as to whether pollution is a result from an accident or from negligence. Hence, the polluter should be punished for his actions, which were caused by his negligence.

The environmental regulations have succeeded regionally mainly due to their economical consequences. The states always fear that the enforcement of an environmental regulation can cause a significant economic disadvantage to some local companies (Sampson 2004). For instance the introduction of more maritime regulations for new environmental issues may create difficulties in the ports of developing countries' (Tan and Khee 2002). Furthermore, the success of pollution prevention regulations to ports and other regulated zones is doubtful (Giziakis and Bardi-Giziaki 2002), (Burgherr (2007).

In the case of oil pollution, Hamzah (2003) noted that this problem is less acute in Europe and North America where national legislation is well developed. In the developed countries the states are in a better position to deal with the oil industry. On the other hand, many developing countries may be in a weak position because their economies depend on foreign oil companies. In addition, these countries may not have the funding or environmental expertise available for the monitoring, research and technology development essential to use these modern high technology compounds. Therefore, they may end up with more contamination because they do not have the necessary regulatory structure to prevent it (Champ 2000).

A new regulation may add more requirements such as certification and inspections as in the case of air emissions (Lin and Lin 2006). States that adopt a regulation have to meet its requirements regarding monitoring compliance of the stakeholders. Monitoring may include adoption of new inspection procedures when the result may be uncertain. However, Talley et al (2005b) concluded that US coast guard machinery inspections are not effective in reducing all oil spills. They also found that some ship characteristics, such as a ship's age, flag of registry and size, are determinants for oil transfer spill. Additionally to these characteristics some operations, such as whether a ship is anchored, moored or docked, towed/towing, underway or adrift at the time of an accident contribute to oil transfer spills. Furthermore, a new environmental regulation may result in increased pollution due to compliance dates. For instance Champ (2003) found that the ban of coatings that contain tributylin (TBT), which is required by the Antifouling Convention, could inadvertently release more TBT to ports and harbors in the five-year compliance period than has been leached from ships in the past 40 years in the same waters.

2.4.3 Accidents in the Jurisdiction of a Coastal State

In the event of an accident, a state may intervene to give directions to the owner of the ship, its master, or to any salvor in possession of the ship. These directions may govern all aspects of the position, movement and salvage of the ship and/or cargo up to and including the destruction of the ship (Bywater 1995). Someone should expect that developed countries by creating a strict regime and following the maritime regulations have created safe sea zones with minimum accidents. However, a statistical analysis proves that these zones are the ones that have a higher risk to suffer accidents (Giziakis and Bardi-Giziaki 2002). Many spills still occur in ecologically sensitive locations because the major maritime transport routes often cross certain geographic areas such as Mexico Gulf, Mediterranean and Bay Gulf (Burgherr 2007).

In the aftermath of *Exxon Valdez* there are many critics regarding the ability of a coastal state to handle an emergency case. One notable case is the *Prestige* accident where Spanish authorities denied the captain's request for a place of refuge (Wang 2006). This action is not against the UNCLOS 1982, which does not obligate states to provide a place of refuge (Murray 2002). On the contrary, despite the captains' request, the Spanish authorities ordered the damaged ship to sail into rough sea away from the coast. The ship sunk and a major oil spill occurred which resulted in public pressure accelerating the banning of single hull ships from European Union seas (Roberts et al 2005). Although the Spanish authorities acted under international law, they suffered major oil pollution and blamed the ship operator and the ship's captain. The ineptitude vulnerability of the Spanish authorities was that they did not carefully examine the consequences of ordering a damaged tanker ship to return to the rough sea jeopardising with pollution the coasts of Spain, Portugal and France.

The case of *Prestige* is not the first in recent maritime history. *Castor* (2001) was a cargo ship, which was sailing around the Mediterranean for nearly forty days with severe crack on its deck (Murray 2002). Several states denied to offer any port of refuge on the ground that the ship was a threat to their environment. Similarly, the French authorities refused the entry of *Erika* on the same grounds as *Castor* but unfortunately, France suffered an oil spill on its coast. British military helicopters saved the ship's crew after the French authorities' request due to lack of appropriate equipment (Murray 2002). The lack of sufficient resources, such as helicopters in the case of *Erica*, is an issue that is related to the cost of implementing maritime regulations and/or the superficiality of many states.

The above cases show that the implemented maritime regulations can fail in the event of an emergency. Powerful states with sufficient knowledge in maritime issues failed to respond to ships' requests. The states fearing the consequences of oil pollution did not provide adequate assistance. Such attitudes by some states may lead the shipping industry to a blame culture where seamen and sea operators will always be targeted.

2.5 Conclusions

This chapter revealed that there are some steps in implementation process that cause rigidity. Behind this stiffness, there are major issues, which are the large amount of money involved and the challenges that the stakeholders face in order to implement a regulation. These major issues are getting more complex due to the international character of the shipping industry. The liberty of a company to locate its branches almost anywhere in the world is offering to the company a significant advantage. The company may choose to locate a branch into the state with fewer regulations. This liberty has been extensively used in the shipping industry due to the necessity to locate a branch near to resources or a commercial centre.

Apart from these two main issues, there are minor but significant obstacles to a unique worldwide maritime regulation implementation which are detected in this chapter and are summarised as below:

1. The shipping industry is not mature enough to rely on a self-regulation approach mainly due to the vague sense of safety standards between its stakeholders (Neser et al 2008), (Goss 2008), (Bennett 2000a).
2. There is a considerable variation of seamen skills (Vanem et al 2008a), (Hetherington et al 2006), (Klikauer and Morris 2003).
3. The regulations may increase the cost of the stakeholders' commercial activities and make the operation of the shipping industry more complicated (Neser et al 2008), (Li and Cullinane 2003).
4. The private stakeholders can increase safety standards at sea (Lambrou et al 2008). However, their willingness to contribute positively depends on the benefits that they can gain towards the costs they should bear.

Chapter 3. Existing and Potential Methods on the Implementation of Maritime Regulations

3.1 Introduction

There is a wide opinion in the shipping industry that there is a risk of excessive and inadequately enforced regulations. The IMO, recognising a potential risk of excessive regulatory regime with inadequate enforcement, decided to change its strategy targeting the worldwide implementation of regulations (IMO 1980). Some of the practices and tools of the IMO are analysed in the first part of this chapter. In the second part, sectors with similar concerns about excessive regulations such as high-risk industries and governments are investigated to compare available practices, which may be applicable to the shipping industry.

3.2 The IMO Strategic Plan

The IMO developed a strategic plan in order to monitor its performance towards its objectives and aims. This strategic plan was firstly introduced in 2004 with the resolution A.909(22) (IMO 2002). This plan was further developed by resolutions A.944(23) (IMO 2004) and A.970(24) (IMO 2006). The innovation of this plan is that the IMO drafted a list of eighteen performance indicators to monitor the achievement of the organization's objectives. According to this plan, the implementation of regulations is monitored through three indicators such as the number of conventions adopted by states, the number of conventions that have entered into force and the number of states that have adopted a self-audit scheme. The other indicators are concerned with various safety statistics such as lives lost, PSC detentions, pollution etc. However, these performance indicators are not a measure system capable of evaluating the success of the organization objectives. Moreover, it appears that these indicators are of equal importance, which may not be always true.

3.3 Tools that the IMO has Introduced for Regulation Implementation

The IMO has adopted the FSA method as a valuable tool to evaluate all aspects of a proposed and an existing maritime regulation in terms of costs-benefits and minimization of any new risk (Rosqvist and Tuominen 2004), (Lois 2004), (IMO 1997a). Furthermore, the IMO encourages coastal states to exercise their authority more rigorously by inspecting foreign ships regarding their compliance with international maritime regulations by strengthening the procedure of the PSC (Sage 2005). In addition, the IMO has introduced the ISM Code as a valuable tool to obligate ship operators to adopt maritime regulations. Many IMO circulars suggest that the ship operators under the terms of the ISM Code should consider their topics. Such a wording is limiting the options of a ship operator to adopt the circular or to justify why he did not follow.

3.3.1 Formal Safety Assessment

The UK's Maritime and Coastguard Agency (MCA) proposed the FSA method to the IMO, which was accepted as an essential tool to evaluate maritime regulations (Ruuda and Mikkelsen 2008), (Alderton and Winchester 2002a), (IMO 1997b). The aim of the FSA is to provide the appropriate scientific background for the design of maritime regulations (Wang 2000). The IMO recognising the need for uniform implementation of maritime regulations, promoted the FSA as a part of the regulatory process (IMO 2000).

Under the FSA method, every new proposed regulation should be thoroughly examined by the following five steps (Lois et al 2004):

1. Identify any hazards.
2. Conduct risk assessment.
3. Find risk control options.
4. Estimate cost benefit estimation.
5. Make recommendations for decision-making.

The FSA method, due to its generic form, was used in many applications to assess the effectiveness of a regulation. Many FSA studies focused on safety of bulk carriers due to the high rate of losses in 1990s. MCA used the FSA to assess the bulk carriers' regulatory regime and made recommendations to the IMO (MCA 1998). Lee et al (2001) studied the hatchway watertight integrity of bulk carriers and Spyrou et al (2003) assessed the standards for construction of bulk carriers. The FSA method was used to other types of ships such as cruise ships (Lois et al 2004) and passenger ships (Tzannatos 2005). The FSA studies were also carried out for various types of accidents such as oil spill accidents (Ventikos and Psaraftis 2004). The FSA was also used to investigate risks in various ship operations such as shipping navigation (Hu et al 2007). The FSA was used to assess the cost effectiveness of hull girder safety (Skjong and Bitner-Gregersen 2002), to evaluate ports safety (Trbojevic and Carr 2000), applicability of the FSA as a tool for coastal states (Sage 2006) and offshore safety (Wang 2002). Antao and Soares (2008) noted that with the development of a structured and systematic methodology such as FSA several studies have been conducted on its application to high-speed crafts.

The FSA method has its limitations according to some researchers which can be summarised as being its generic form and lack of its continuous use for every new regulation. The FSA uses the generic ship model, which has raised arguments that a successful FSA study should use a specific ship model (Chantelauve 2004). In addition, it is argued that some steps of the FSA, particularly risk control options, should be obtained with more scientific methods rather than the existing fault tree and event tree analysis (Kaneko 2002), (Mennis 2005). Furthermore, in the FSA methodology, the costs and benefits that may be generated by the implementation of a regulation are addressed in a partial and very generic way. For instance, Vanem et al (2008b) noted that in FSA studies, the cost-effective criteria do not take any particular stakeholders' view, and they are not concerned with who would have to pay for implementation of risk control options. In terms of safety the FSA is addressing three levels of risk: intolerable, As Low As Reasonably Practicable (ALARP) and negligible. For risks within the ALARP area, cost-effective considerations apply to the amount of resources that should be spent on risk mitigation. The IMO FSA guidelines recognized this as the current best practice, although criticism of the ALARP principle has occurred (Vanem et al 2008a).

A major issue regarding the application of the FSA in the IMO decision-making process is that it has not applied to all regulations proposed (Skjong 2003). Wang (2006) noticed that several possible options regarding the application of the FSA are currently under debate both at the IMO and by its member states. One reason for these debates may be that the FSA greatly depends on historical failure data, which may not be reliable and may result in ambiguous results (Wang 2000).

An outcome of the FSA method is very likely to depend on the different data that will be selected and evaluated (Rosqvist and Tuominen 2004). An example to illustrate this issue is the difference between the FSA conclusions made by Greece and the UK in respect of double skin bulk carriers' efficiency (IMO 2004). Therefore, the FSA may not explicitly address the issue of quality assurance. The role of the stakeholders and experts in providing qualitative and quantitative information is crucial with respect to the quality of the FSA (Rosqvist and Tuominen 2004). Moreover, the FSA focuses on identification of cost–benefit risk-reducing measures and not on explicit reduction of individual or societal risks. This is understandable since the IMO's goal is to have risk-based methodology widely accepted by the member states that may have different approaches to risk criteria, or may not have risk criteria at all (Trbojevic 2006).

It should be stressed that the FSA method is not designed to assist a ship operator to improve its management or to implement a new regulation although some shipowners have developed their own safety cases (Wang 2006). On the contrary, it is applicable governments and non-government organizations working within the framework of the IMO (IMO 1997b).

3.3.2 International Safety Management Code for the Safety of Ships and Pollution Prevention

It is believed that a high percentage of accidents are due to human error and lack of effective management (Thai and Grewal 2006), (Toremar 2000). An attempt to address this issue is to put an obligation on ship operators to prove with records that their ships and companies are following the IMO regulations. This idea of safety management practice is already in use by other industries (Goulielmos et al 2008), (Trbojevic and Carr 2000).

The IMO set the quality standard for ship operators by introducing the ISM Code in 1993 (Pun et al 2003). Under the ISM Code requirements, the ship operators should establish their own procedures according to maritime regulations of the flag state of each ship and record their basic activities (Paixao and Marlow 2001). Every ship operator should design a Safety Management System (SMS) that will include procedures for continuous improvement in the areas of policy, planning, communication, emergency preparedness, emergency response, checking and corrective actions (Pun et al 2003), (IMO 1993). The verification of an effective SMS requires regular audits (Thai and Grewal 2006), (Chen 2000). The SMS should be audited twice per year once internally from the ship operator and once from an externally approved organisation such as a classification society (Chen 2000). However, compliance with the ISM Code does go much further than mere certification upon a successful external audit and the depth of compliance still remains to be desired with regard to the enforcement of quality as well as the commitment of the shipping companies (Fafaliou et al 2006).

The ISM Code has its limitations, which are lack of commitment from the top management, lack of enforcement by some states and the potential criminal liability which employees are exposed to. The ISM Code requires from the ship operators to enforce flag states maritime regulations rather than the IMO standards (Chen 2000). The ISM Code does not impose criminal liability on non-compliant parties, however when the ISM code is incorporated into the domestic law of some states, a breach of it could result in criminal liability for the carrier or the master or crew concerned (Chen 2000). Failure of a ship operator to comply with the ISM Code requirements can lead to claims against him by third parties such as cargo owners (Chen 2000). It is argued that the ISM Code is an attempt to regulate human actions because they are likely to lead to ship accidents claims (Talley et al 2005). An SMS depends on an effective management of information from the ship and other sources such as PSC and classification societies inspections. This information is used for carrying out quality ship-management and quality ship-maintenance (Goulielmos and Tzannatos 1997). There are many different international and national safety standards, which provide guidance to help ship operators develop their SMS (Pun et al 2003). The ISM Code structure and success is based on leadership and commitment, which their objectives may vary to every manager. Lack of knowledge and experience may mislead a ship operator about the safety standards of his ships. Many small-scale owners, representing a significant proportion of the market, may experience various difficulties in order to comply with the ISM Code requirements. They may choose to give their ships management to a third party ship management companies (Mitroussi 2004a). Under the ISM Code requirements, ship operators should provide training to crew members in order to be capable of operating the ship (Norris 2007). However, training requirements may be difficult to be fulfilled in a modern and automatic ship with new introduced technologies (Goulielmos 2003). It has been found that ISM Code certified ships' bridge teams are highly variable in quality. Many teams appear to lack the appropriate training, attitude, culture and management (Thai and Grewal 2006). Consequently, the shipping industry may become very difficult for small ship operators to run their business. In addition, some ship operators may pose an over-reliance on paperwork to solve safety problems or adjusting the procedures to fit the existing culture believing this to be satisfactory. Employees over-burdened with paperwork required by the ISM Code may prefer to take shortcuts (Thai and Grewal 2006).

Many academics have identified that the safety priorities of a company are subject to its safety culture. The safety culture of a company is established by its top management team and progressively it is adopted by its employees (Havold 2000). Safety culture is difficult to be accurately described, however it consists of essential procedures such as communications, decision-making, problem solving and conflict solving (Havold 2005). Havold (2005) suggested that the safety culture of a shipping company is related to the nationality of its employees. A mix of nationalities is a disadvantage for a company in order to develop its safety culture. Moreover, it is broadly recognised that the modern management systems were introduced, mainly from the USA, together with new technologies (Hofstede 1983). However, these systems may not be appropriate for other national cultures (Hofstede 1983), (Brock 2005), (Pagel et al 2005), (Dimitriades 2005). The ISM Code was enforced without recognising the different national cultures in the shipping industry. The ISM Code issues such as researching, authority, evaluation and review may create difficulties for people from a variety of cultures, while implementing fundamental functions of an SMS.

3.3.3 Port State Control

The PSC authority is not a new concept and was used in the past extensively for customs and immigration purposes (Molenaar 2007). The PSC authority in terms of maritime regulations implementation was extended by UNCLOS 1982 where the international legal framework regulating the rights and powers of coastal states toward foreign ships was developed (Sage 2006). The IMO issued various circulars for the guidance of coastal states of how to inspect foreign ships regarding their compliance with international maritime regulations (Knapp and Franses 2007). The PSC has posed some success in its overall performance by contributing positively to safety at sea. However, it has been alleged that it is not the panacea for improving safety at sea and implementing the IMO regulations. Its role in regulatory implementation should be distinguished from the FSA and the ISM Code due to its police nature. In this section, various PSC issues are listed.

According to the PSC requirements, official inspectors from a state are entitled to inspect foreign ships at port. In case that during an inspection the PSC officer finds a ship failing to comply with any maritime regulation then he has the authority to take a series of measures to prevent that it will sail (Li and Zheng 2008). Minor failures are recorded by PSC officers as deficiencies and should be rectified in few days. If in a ship, a major deficiency is found, or a high number of minor deficiencies are identified, it will be detained at port until the deficiencies are rectified. In an extreme situation that a ship is in such a bad condition where immediate repairs are required, the PSC authority may allow the ship to sail to the nearest shipyard for immediate repairs (Molenaar 2007), (Keselj 1999).

There are some limitations of PSC in terms of its quality, operational costs and effectiveness. One limitation is the variety of PSC officers' skills (Bloor et al 2006). Although the IMO has issued a resolution regarding the minimum qualifications of PSC officers, the standards of each state vary (Knapp and Franses 2007a). In addition, some states have acknowledged their inability to cope with the complicated requirements of the IMO conventions. However, these states still carry out inspections and detain foreign ships that enter into their jurisdictions. A second limitation is the integrity of the PSC officers (Bloor et al 2006). In some developing states where the PSC officers' wages are low, bribery may be welcomed. In addition, bribery may be considered as a significant income for some PSC officers and they may demand it by threatening the ship's captain with detention. Of course, corruption should not be considered as a privilege of developing states. A third limitation can be the fact that the crew members of a ship that is found with deficiencies may find themselves in the unpleasant position to defend their position against any deficiency to the ship operator. Consequently, PSC inspections may not be welcomed from the crew members, which may try to mislead the inspectors for any potential deficiencies. A fourth limitation can be found to the inadequate human resources of PSC authorities. In some ports, due to traffic congestion of ships PSC officers may find it difficult to inspect all ships. Therefore, many PSCs have adopted a target factor system, which identifies certain ships where there is a need for immediate inspection according to their characteristics such as the flag, classification society, type and age of a ship (Cariou et al 2008), (Bloor 2007), (Knapp and Franses 2007b). A major disadvantage of this system is that its factors rely on statistics from previous records, which may not represent the true condition of a ship.

A fifth limitation is the costs of PSC inspections, which can be divided into three categories:

1. Administration costs of PSC.
2. Ports' competitiveness.
3. Cost of deficiencies rectification.

The administration costs are all the necessary expenses that a coastal state must bear in order to maintain a PSC administration such as training of PSC officers (Li and Zheng 2008). A state that is carrying out rigorous PSC inspections may create a commercial disadvantage for its ports. In contrast, other states in the same region that carry out more lax PSC inspections may attract ships and obtain commercial benefits (Keselj 1999). The third category of costs generates a burden for the ship operator

(Molenaar 2007). Some deficiencies may be very costly due to repairs and availability of the required equipment especially in small ports.

Many PSC have launched a regional cooperation known as Memorandum of Understanding (MOU) agreements. The Paris MOU organization, which consists of twenty-five member states, decided to ban any ship that exceeds a specific number of detentions from its ports (Molenaar 2007). The ban rule of Paris MOU states that any ship with more than two or three detentions, depending in its flag, will be banned from all Paris MOU members (Paris MOU 2006). It is obvious that any ship, which is detained in any Paris MOU member state, will lose some of its commercial value since it is at risk to be banned from a huge market of twenty-three European states, Canada and Russian Federation. It should be stressed that a ship operator may appeal against a detention of his ships, however the detention cannot be lifted even if it may be wrongful.

3.4 Investigation of Sectors with Excessive Regulatory Regimes

The above literature review has revealed a list of issues that produce obstacles to the implementation of maritime regulations worldwide. Many academics proposed some measures such as quality management and training. However, they did not propose any comprehensive strategy in order to succeed a unique worldwide regulatory implementation. Therefore, for the needs of this research it was necessary to investigate how the regulatory implementation is achieved in other industries with excessive regulations. Moreover, these industries are associated with high risk so that it is meaningful to carry out an effective comparison between them and the shipping industry. The industries that were chosen are aviation, nuclear plants, chemical and petrochemical ones.

Similar to the IMO many governments face the risk of excessive regulations. Governments are concerned with the issue of effective regulations. An effective regulation should not pose a disadvantage to small companies while it should be rigorous at the same time. Furthermore, a government should drive local companies to follow innovation and modern practices. Thus, various tactics used by governments were investigated as an alternative approach from these that exist in industries.

3.4.1 The Offshore Industry Regulatory Regime

The offshore industry is the closest industry to shipping due to its sea environment and the associated hazards and problems. It is also bound by various regulations at both local and international levels. For instance, in some countries, the political regime may perceive labour as cheap and dispensable while on other countries, the moral and ethical obligations of governments associated with protecting people from harm at work should be a sufficiently strong motivating force to ensure implementation of effective safety management systems that go beyond local legislative requirements (Mearns and Yule 2008).

Up to date, two possible solutions appear in the offshore industry regarding compliance with regulations. One is the implementation of quality systems such as ISO standards and the development of new procedures where appropriate, resulting in the derivation of revised safety factors for offshore structures (Stacey and Sharp 2007), (Mohamed Ali and Louca 2008). The other, which is suggested by many academics, is to build a stronger safety culture among employees of an offshore organisation in order to increase the efficiency of a quality system (Conchie and Donald 2008), (Mearns and Yule 2008).

The above two solutions have partially been introduced in the shipping industry through the ISM Code. However, this partial enforcement may be one main reason of the low achievements as it was discussed in Section 3.3.2.

3.4.2 The Aviation Industry Regulatory Regime

Aviation has much in common with the maritime industry. Both are international in nature, their fleets travel worldwide carrying goods and people with the headquarters of the company often based in one country. Aviation has a mechanism for national and international regulations, which is the system of aircraft registration (Odeke 2005). International regulations are agreed on by multilateral agreements in the context of EU and International Civil Aviation Organisation (Brooker 2006a). Additionally, an airline should comply with government regulations (Liou et al 2008). However, until recently aviation was regulated only in terms of safety standards and not to commercial practices (Zhang and Round 2008), a situation that is changing due to security incidents (Bailey 2002).

It is to be expected that both industries would adopt similar practices in order to deal with problems of safety and operating internationally. The IMO introduced the ISM Code in the expectation of bringing the safety standards of shipping much closer to that of the aviation industry (Chen 2000). Moreover, the IMO has taken the model used in international aviation security to structure its own plan to the terrorist threat (Brooks and Button 2006). In terms of risk assessment techniques the IMO adopted a proactive approach to safety known as the FSA. Checklists are used for various procedures in the aircraft (Degani and Wiener 1993), a practice that has been adopted in the shipping industry.

There is some criticism regarding aviation regulations and their efficiency. There is an argument that the liberalisation of aviation should be limited and thought must be given to the safety consequences of regulations and appropriate inspections of real operational practices (Brooker 2006a). Furthermore, Liou et al (2008) noted that as a result of regulatory pressure, SMSs have been institutionalised by most airlines but there is no comprehensive SMS model for the aviation industry, and the structural relations among the safety factors of a SMS still remain unknown. Brooker (2006b) in his study concluded the following points:

1. There is a risk in generating unnecessary and/or unproductive bureaucracy in safety regulation.
2. The safety regulations need to be exposed to scrutiny of professional criticism, with all the key source material underpinning regulations being in the public domain.

3. The scope of definitions and characteristics should be as comprehensive and open as possible, and safety responsibilities should be clear, complete and comprehensive.

From the above list, it appears that in aviation a concern has been raised with the purpose and design of regulations similar to the shipping industry. However, the aviation industry has not developed a method or tool to assist with this issue.

3.4.3 The Nuclear Industry Regulatory Regime

The nuclear industry has been identified as a high-risk industry therefore from its first stage it was highly monitored with strict regulations (Keller and Modarres 2005). Many Probabilistic Risk Assessment (PRA) methods were introduced to the nuclear industry fifty years ago as an adjunct, prominent force in the nuclear plant regulation (Modarres 2005). One of them is the safety management system (Trbojevic and Carr 2000) that was implemented in the shipping industry as the ISM Code. Another is the risk assessment approach, which was transferred to shipping in the context of the FSA.

In complex systems such as a nuclear plant, it is well known that the provisions of well defined procedures allow operators to clarify what needs to be done and how to do it is one of the requisites to secure their safety (Park et al 2005). The regulatory perspective is in a state of transition from a command and control framework to one that is risk-informed and performance-based (Hess et al 2005), (Modarres 2005). There is theoretical support that a transition to a risk-informed, performance based regulatory structure will provide long-term safety benefits and that it can be accomplished without incurring significant public safety impact during the transition.

Hess et al (2005) noted that the operation of a nuclear power plant encompasses many significant interrelated activities performed by numerous individuals. Personnel having highly specialized skill sets typically performs these activities. Thus, a nuclear power plant has the characteristics of what has been described by many academics as a "machine bureaucracy" (Hess et al 2005). This bureaucracy is distinguished by the use of highly formalized and specialized procedures to accomplish operating tasks. The personnel follow formal rules and regulations and communication channels in a relatively centralized decision-making process within an extensive administrative structure. However, a number of failures in the area of safety management procedures have been identified such as poor management oversight, poor training and deliberate procedural violations (Kettunen et al 2007).

In contrast to the maritime industry, it should be noted that the nuclear plants are located in one state and are bound by the laws of the state. In addition, the majority of the employees in a nuclear plant will be scientists with specific knowledge whereas in the maritime industry the standards for seamen are comparatively low.

3.4.4 The Process Industry Regulatory Regime

In process industries, recognising that companies should comply with all relevant regulations, a variety of methods was developed. One method introduced was the Safety Information Management (SIM) approach (Tzou et al 2004). Under the SIM approach all regulations are an important part of the system. The method is focusing on handling of all the information effectively by gathering data from near misses analysis and taking corrective action supported by paperwork and documentation (Yoon et al 2000). According to this view, companies must establish procedures that will enable them to have easy access to new regulations, to evaluate and provide training to their employees. It is suggested that these procedures should be in place during the lifecycle of a product (He et al 2006).

Safety information systems that are already used in the process industry are ISO 9001:2000, ISO 14001 and OHSAS 18001 (Duijm et al 2008), (Mannan et al 2007). These systems are used as quality system tools in order to extend narrow regulatory compliance (Gillespie 1995). An examination of the clauses and sub-clauses of ISO 9001:2000, ISO 14001 and OHSAS 18001 has shown that there are significant differences in the scope of the standards, particularly in those areas dealing with the communication of policy, involvement in continual improvement activity, consultation about the setting of objectives and awareness of procedures. Some of the

SIM systems require documentation, which is likely to present problems during their implementation (Wilkinson and Dale 2002). However, it should be stressed that ISO standards are voluntary standards, and not regulations. ISO is a requirement imposed by some governmental agencies on companies competing for public procurement contracts and some major customer groups (such as automotive) on their suppliers (Kleindorfer and Saad 2005).

Safety management has been used as a tool of regulatory implementation by emphasizing different aspects of management. In the USA employee safety is a key element in most safety management regulations (Grote and Kuenzler 2000). It is also indicated that safety may still be insufficiently incorporated into formal safety management procedures. Despite regulations, safety can only be ensured by daily work practice. The efficiency of regulations in various industries has been criticised (Richards et al 2000). It is proposed that a self-regulation approach should be adopted and accompanied by a robust audit system and with a stricter enforcement regime than the current one appearing to be operating. Most practitioners in the process industry believe that an effective management system is the key to prevention of incidents. The decrease in incidents is less than expected because at the time when the process safety regulations were introduced there was optimism that these measures would lead to very significant reductions in accidents (Rosenthal et al 2006). In the chemical process industry, the legal regulations are considered as the appropriate safety technology for inherent safety (Shah et al 2003).

Recognising the importance of quality systems the American Bureau of Shipping (ABS) proposed various SIM systems for the shipping industry such as ISO 9000 for quality standards, ISO 14001 for environmental issues, and OHSAS 18001 for safety and health aspects (ABS 2006). Although not yet mandatory, ABS states that shipping companies may reduce most potential accidents by adopting such systems. In addition, major industrial organizations suggest that quality systems such as Tanker Management and Safety Assessment (TMSA) may be a solution to the implementation of maritime regulations by the tanker's operators (OCIMF 2004).

3.5 Regulatory Implementation Assessment of Governments

The issue of excessive regulations is not unique for the high-risk industries. Governments are threatened by the risk of excessive regulations. The approach that has been adopted by many governments is to incorporate the Regulatory Implementation Assessment (RIA) into their existing policy-making processes (Staronova et al 2007), (Kirkpatrick et al 2004). The aim is to produce effective regulations and minimize the administration costs, which are a heavy economic burden for the states.

According to the RIA approach issues such as costs, benefits, scope, consultation of public sector, and risk assessment should be included in the design process of a regulation (Ballantine and Devoland 2006). Furthermore, more broad issues are included such as "do nothing option" and "small firm impact" (Vickers 2008). The "do nothing option" is based on the fact that sometimes a proposed regulation can generate more difficulties than the result it may produce. Difficulties of companies to implement a regulation may need additional regulation to be involved by producing a vicious circle. The "small firm impact" is also a fundamental issue since every industry should be open to anyone who wants to get involved. However, some academics have raised arguments about RIA pointing some weaknesses of the process relating to competence of staff. Lofstedt (2007) noted that RIAs are still haphazard, regulations are at times based on emotions, not science.

Although the IMO has introduced the FSA approach, maybe the RIA approach should be used to address more specific issues when producing regulations. The economic burden of one small stakeholder generated by a regulation should be taken into account by regulators. Furthermore, the "do nothing option" by regulators may work as a resistance to excess negative media coverage in case where there is scientific doubt about the results of a proposed regulation.

3.6 Conclusions

The examined industries and governments have focused on detailed monitoring systems in order to keep pace with applicable regulations and be able to prevent any failures. Their approach is that compliance with regulations can minimise the risk of an accident. Their practices are in the spirit of establishing proactive measures and manage them. In contrast, the existing tools in the shipping industry are very generic. Consequently, their results are not of high importance and they cannot really produce valuable results. Hence, the shipping industry is relying more on the current police approach that has been adopted for many years which results only in a move of many stakeholders to more lax regimes. Therefore, the old-fashioned approach of penalizing the stakeholders or their employees that fail to implement a maritime regulation should change to a new approach targeting a fair balance of commercial costs and benefits.

Chapter 4. A Proposed Methodology for Evaluating the Implementation Performance of a Maritime Regulation

4.1 Introduction

The literature review reveals that many world states have difficulties to meet the international agreements of the IMO without the involvement of all the stakeholders of the shipping industry. Furthermore, the shipping industry is unfamiliar of effective management systems that can assist its stakeholders to monitor their regulatory implementation performance. In this chapter a methodology is introduced which focuses on the benefits and costs that a regulation may cause to a stakeholder. It is suggested that excessive and unnecessary regulations may lead certain stakeholders to seek for more lax regulatory regimes where they can run their business. In addition, a performance management system is developed to measure the profit of a stakeholder as a result of his adequate regulatory implementation. The use of such a system will highlight to a stakeholder that he may have some positive commercial advantages by implementing a specific maritime regulation.

4.2 Develop a Framework

The contribution of all the stakeholders is one promising solution in order to improve the effective implementation of maritime regulations. The stakeholders should be able to involve voluntarily into the compliance of a newly introduced regulation. To achieve this voluntary participation a new regulation should be designed on the basis that will not overburden a small group of stakeholders. In addition, a newly introduced regulation should neither restrict nor inhibit a stakeholder from being either innovative or excelling in its business. Both targets can be achieved by a strategy that will focus on the following points:

1. Monitoring the implementation performance of the industry.
2. Monitoring the implementation performance of each stakeholder.

3. Provide a self-assessment tool to the stakeholder with regard to their implementation performance.

To address the above points a methodology is developed in this section. A combination of the BSC, the AHP, the Delphi method and the Fuzzy Set Theory, which are described below, are used to devise an appropriate methodology. The BSC can provide a strategy to obtain the desired result by producing scorecards. Industrial experts test the BSC scorecards' validity and provide data through surveys by following the principles of the Delphi method. The Fuzzy Set Theory is used as a tool to evaluate experts' judgements. The AHP method is used to rank the judgements of experts by making pairwise comparisons. At the end of the process, valuable conclusions can be drawn regarding the most appropriate method to develop a tool to estimate the performance of maritime regulations

4.2.1 Balanced Scorecard

When a stakeholder has to implement a regulation, it is often expected that he will suffer a burden. This burden can be estimated by making comparisons between the benefits and costs that he will sustain. A valuable method that can be used for investigating costs and benefits of maritime regulations is the BSC established by Kaplan and Norton (1996a,b). The BSC is used in the business world to assist companies improving their performance by measuring and evaluating their strategies. The use of the BSC can assist a company to achieve a goal by monitoring multiple perspectives of the strategy at the same time as it is shown in Figure 4.1. Focusing on only one perspective can lead a company to fail in its goal because there are many other non-financial aspects that should be monitored by the company.

The balanced scorecard has been used broadly as a management tool in a variety of industries. The BSC can be found in applications regarding management performance such as supply chain management (Park et al 2005), performance measurement of management (Franco-Santos and Bourne 2005), process effectiveness and efficiency of organisations (Solano et al 2003), strategic business for the industry (Ahn 2001) and improvement of organizational performance (Decoene and Bruggeman 2006).

The BSC approach has also been adopted in information management in subsidiaries of multinational corporations (Chung et al 2006), management information systems (Kettunen and Kantola 2005), and to measure the performance for plant safety in the process industries (Tzou et al 2004). More applications of the BSC have also been seen in general applications such as evaluating the value that IT adds to the process of project information management in construction (Stewart and Mohamed 2001, 2003), healthcare organisations evaluation (Chan 2006), assessing public relations and communications performance (Fleisher and Mahaffy 1997), assessing corporate strategies and environmental forces (Sohn et al 2003). It has also been employed as an alternative option to existing total quality management systems such as ISO (Watkins and Arrington 2007), (Wagner 2007). In the maritime industry, the BSC has so far been used in offshore health-and-safety studies (Mearns and Havold 2003).

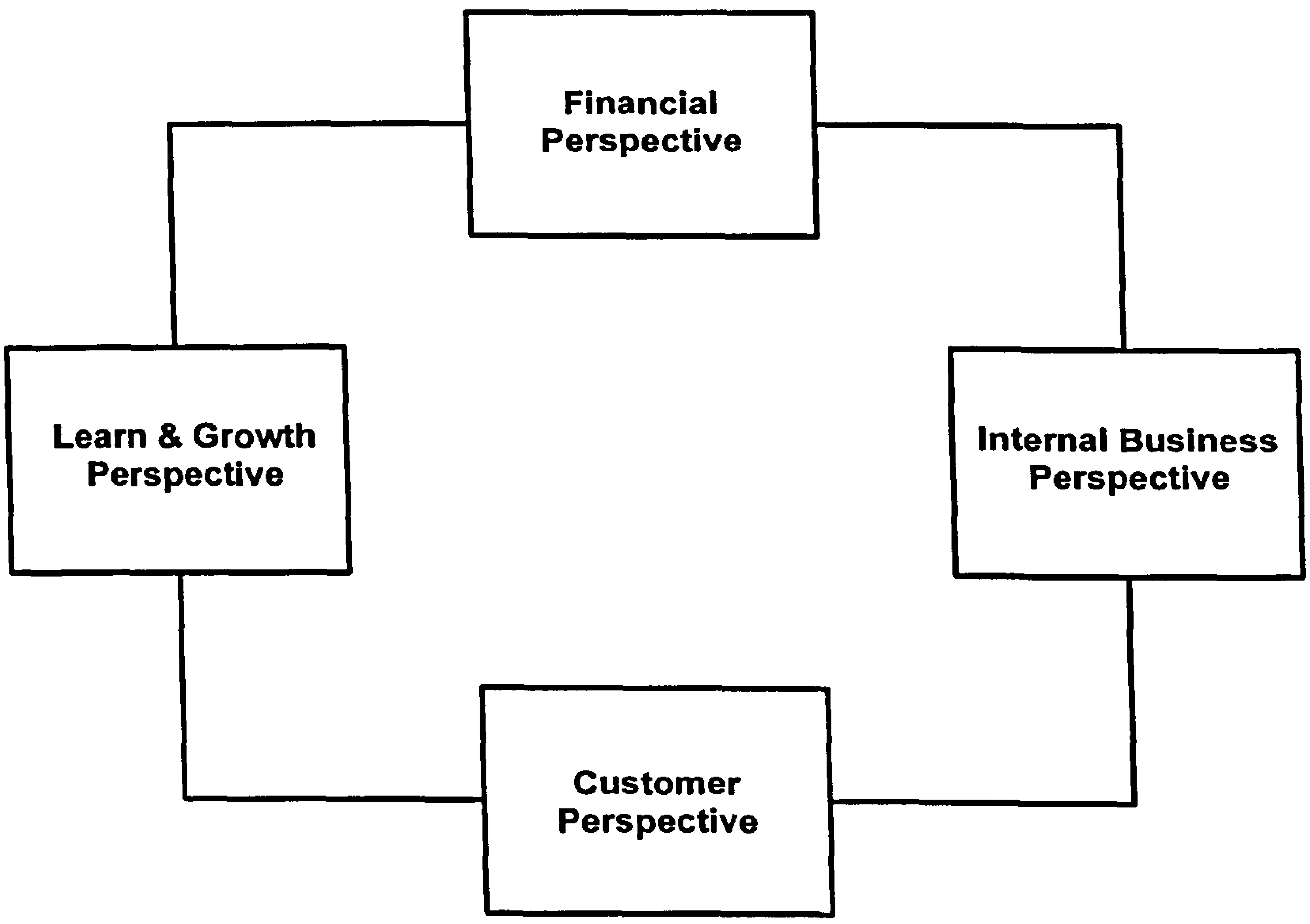

Figure 4.1. The Perspectives of a Balanced Scorecard

There are many studies concerning the BSC as a potential tool to evaluate the implementation of a regulation. For instance, Mearns and Havold (2003) measured Health and Safety Executive regulation compliance in the offshore industry by using the BSC. Kettunen and Kantola (2005) noted that higher education in Finland could accomplish self-regulation by using the BSC approach, which is useful, not only in accomplishing the objectives, measures and targets of an institution's strategy but also in the planning of a management information system. The BSC approach has recently been used by many companies to monitor their regulatory compliance (Stevens 2006), (Huang 2007), (Garcıa-Valderrama 2008), (Pedersen and Neergaard 2008), (Osmundsen et al 2008). Additionally various governments and administrations have used the BSC for monitoring a variety of regulatory issues or their overall performance (Phillips and Phillips 2007), (Ramos et al 2007), (Farneti and Guthrie 2008), (Lee 2008).

The BSC is a capable method with simplicity in setting and evaluating goals. A main advantage of the BSC over other performance measurement methods is that it enables monitoring of multiple perspectives of an issue at the same time leading to a common target (Kaplan and Norton 1996a,b), (Lee and Ko 2000), (Zee and Jong 1999). Moreover, it is a sound method to evaluate the performance of all divisions of an organisation by issuing cascade BSCs. It has been used as a quality management tool because it is simple and easy for all people involved at all levels and links measures to a strategy (McAdam and O'Neill 1999), (Mearns and Havold 2003).

The first and most important step for a company that wants to adopt the BSC approach is to establish a goal that it desires to achieve. The achievement of the goal can be evaluated by using various perspectives and measures set by the company's managers. According to the BSC method four performance perspectives can be identified; a) financial, b) learning and growth, c) customer and d) internal business (Kaplan and Norton 1996a,b). However, a company may choose to use more or different perspectives. Every perspective should be described by certain measures in order to be monitored. A scorecard is produced with all the described perspectives and measures that a company has chosen. With the scorecard as a strategic monitoring tool, the weakness of a company in achieving the desired goal can be measured and corrected.

Researchers who use the BSC argue that the use of one generic BSC by the managers of a company may not be effective (Kaplan and Norton 2005), (Mearns and Havold 2003). They suggest that every department of a company should have its own BSC. All these BSCs should be designed in a cascade form for all departments and levels from the top to the bottom of a company. The reason for using many cascade BSCs is that in the modern complex business world the strategy of a company should be shared between its employees at all levels. Hence, any department in using its own scorecard can contribute to company's strategy and evaluate the company or department performance. It is further suggested that every employee should have his own personal scorecard so as to be able to monitor his performance.

A stakeholder needs a tool that will allow him to monitor and measure the implementation of a regulation at all levels of his organisation. By adopting the same scorecards for a company, it is possible to develop a common performance management system in terms of different perspectives and departments. Then the performance from various sources can be measurable on a common space. Therefore, the BSC is adopted in this thesis as a strategic tool capable of monitoring the regulatory performance of the shipping industry.

4.2.2 Analytic Hierarchy Process

A main limitation of the BSC is that it is not a procedure of weighting its perspectives. In real world, although the four perspectives of a regulation need to be met by each stakeholder they may be in different priority for a stakeholder. Therefore, it is appropriate to provide the means of ranking the four proposed perspectives for their priorities. There are some available methods with regard to weighting elements of a given problem such as TOPSIS and AHP (Buzbura and Beskese 2007), (Berrah et al 2007). However, the AHP has some advantages compared to other methods because of its simplicity and its ability to rank parts of a multi-criteria problem in a hierarchical structure (Chan 2006).

AHP established by Saaty (1990) is a method that can solve multiple criteria decision problems by setting priorities as is shown in Figure 4.2. The best decision can be made when qualitative and quantitative aspects of a decision need to be included (Saaty 1990, 2003). The application of the AHP to a complex problem consists of the following four steps (Cheng et al 1999):

1. Break down the complex problem into a number of small elements and structure them in a hierarchy.
2. Make pairwise comparisons among the elements.
3. Estimate the relative weights of the elements.
4. Aggregate these relative weights and synthesise them for the final measurement of given decision alternatives.

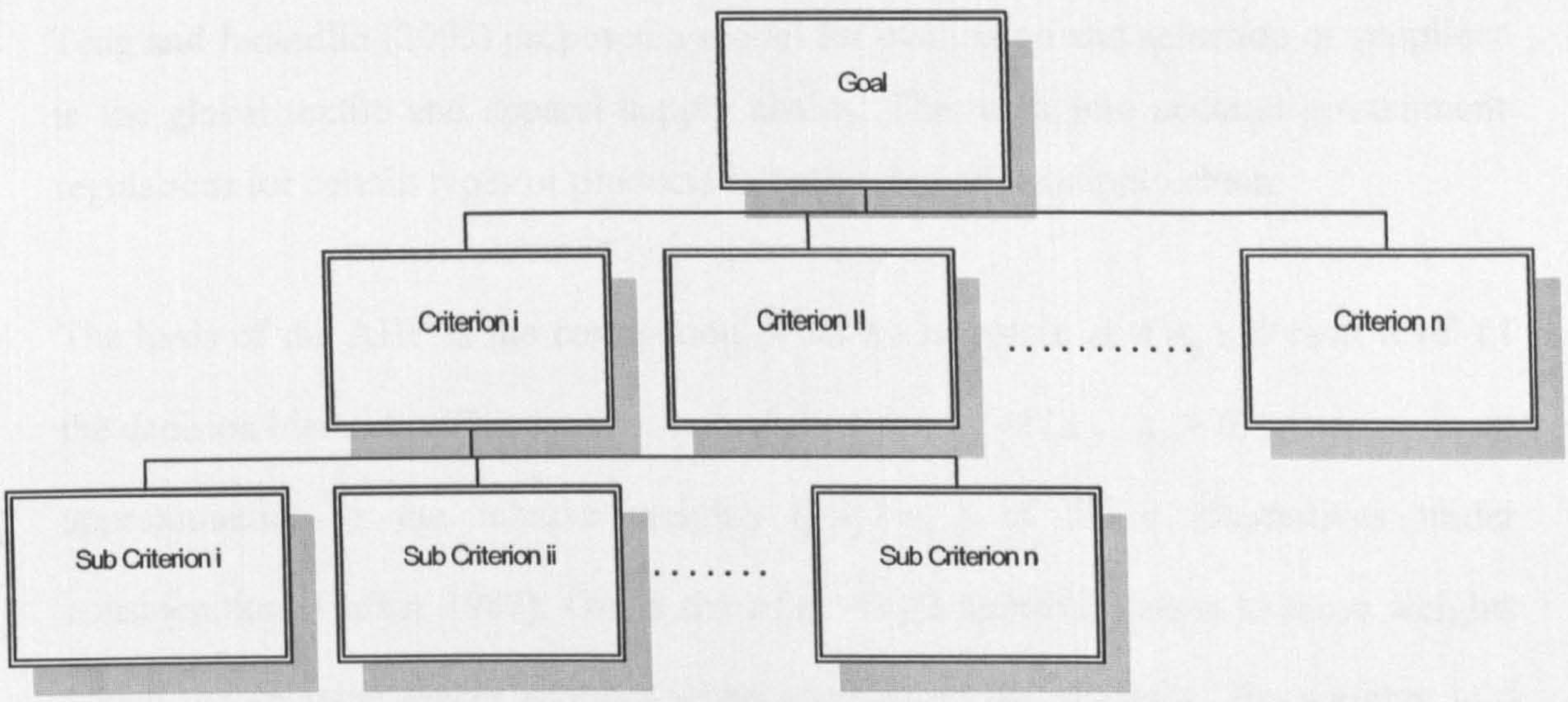

Figure 4.2. An Example of a Hierarchical Structure

Vaidya and Kumar (2006) claimed that the AHP method is so popular to researchers that it has been used in nearly 150 applications. Sohn et al (2003) proposed a calculation of weights for BSC measures where the relative weights for each performance measured can be calculated using the AHP. Ramanathan and Ganesh (1994) investigated the methods for group preference aggregation with the AHP. Cheng (1996) and Cheng et al (1999) used the AHP to evaluate the effectiveness of weapons such as naval tactical missile systems and attack helicopters respectively. Chou et al (2005) proposed a framework for performance evaluation of the industry portals for small and medium sized enterprises. Chien and Su (2003) used the AHP to resolve customer satisfaction strategy decisions. In the maritime field, the AHP has been used to investigate the human reliability of ship operations (Ung et al 2006), design support evaluation for the offshore industry (Sii and Wang 2003) and selection of Nigerian ports regarding service quality (Ugboma et al 2004).

The AHP has not been directly used to solve a regulation implementation issue, however the issue of regulations has been incorporated in many AHP research projects. Badri (1999) proposed an AHP methodology in order to help a facility plan personnel location strategies. In his proposed AHP hierarchy, in the second level, one of the criteria was government regulations. Brown and Haugene (1998) suggested that the ISM Code introduced the concept of self-regulation. In the concept of the ISM Code the AHP was used to analyse the effect of human error in tanker grounding. Teng and Jaramillo (2005) proposed a model for evaluation and selection of suppliers in the global textile and apparel supply chains. This took into account government regulations for certain types of products in both sides of the supply chain.

The basis of the AHP is the completion of an $n \times n$ matrix $A=(a_{ij})$ at each level of the decision hierarchy. This matrix A is of the form $a_{ij}=1/a_{ji}$, $a_{ij}>0$, where a_{ij} is an approximation to the relative weights (w_i/w_j) of the n alternatives under consideration (Harker 1987). Given the $n(n-1)/2$ approximations to these weights which the decision maker supplies when completing the matrix A, the weights w = (w_i) are found by solving the following eigenvector problem (Saaty 1977):

$$Aw = \lambda_{\max} w \tag{1}$$

where $\lambda_{\max}$ is the principal eigenvalue of the matrix A.

Saaty (1977) used the Perron root theorem, which states that there is one largest real positive eigenvalue for the matrix A with positive entries whose associated eigenvector is the vector of weights. This unique vector is normalized by having its entries sum to a unit. Thus, the activities in the lowest level of a hierarchy have a vector of weights with respect to each criterion in the next level derived from a matrix of pairwise comparisons with respect to that criterion (Saaty 1994). In an arbitrary random reciprocal matrix, A there exist some *i*, *j* and *k* for which $\alpha_{ij}\alpha_{jk} \neq \alpha_{ik}$. Then the average of normalized columns of the reciprocal matrix provides a good estimate of the eigenvector (Vargas 1982):

$$w_i = \frac{1}{n}\sum_{j=1}^{n}\frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}} \quad (2)$$

When the numerous pairwise comparisons are evaluated, some degree of inconsistency could be expected to exist in almost any set of pairwise comparisons. The AHP method provides a measure of the consistency for pairwise comparisons by introducing the consistency index (*CI*) and consistency ratio (*CR*), which can be calculated by using Equations 3 and 4 (Ung et al 2006). The λ_{max} is the maximum eigenvalue of an $n \times n$ comparison matrix and is calculated by Equation 5 (Vargas 1982). *RI* is the random index for the matrix size, *n* and depends on the number of items being compared and is shown in Table 4.1 (Saaty 1994). If *CR* is valued less than or equal to 0.1 then a consistency is indicated and the pairwise comparisons are reasonable. However, this value is arbitrary and has not been proved mathematically. This is the reason that Saaty suggested that *CR* value could be near 0.2 and any attempt to reduce this value will not necessarily improve the judgement (Dadkhah and Zahedi 1993), (Wedley 1993). Furthermore, in actual world it is often very difficult to achieve this value mainly due to the disagreement of experts.

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (3)$$

$$CR = \frac{CI}{RI} \quad (4)$$

$$\sum_{j=1}^{n} a_{ij} w_i = \lambda_{max} w_j \quad (5)$$

Table 4.1. Average Random Index Values

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

4.2.3 Delphi Method

AHP and BSC can be used as an appropriate framework for the proposed methodology. However, the findings from literature review show that there is a lack of reliable data since there is not any relevant research carried out in the past. AHP is a method for decision making and ranking certain criteria in terms of their weights. However, the weight of these criteria can only be determined based on certain data. In the case where data are unavailable or limited it may be appropriate to consult with experts which with their high level of experience can provide a form of data. One method to collect data is the Delphi method with which the degree of objectivity in pooling evidence from various sources can be further improved (Sii and Wang 2003). Other researchers (Kaufmann and Gupta, 1988), (Chang and Wang 2006) mentioned that this method has the following advantages:

1. To decrease the times of questionnaire survey.
2. To avoid distorting the individual expert opinion.
3. To clearly express the semantic structure of predicted items.
4. To consider the fuzzy nature during the interview process.

The Delphi and AHP methods have been used in a wide number of studies as the one complements the other. Sii and Wang (2003) showed an illustrative example that the formal decision-making techniques such as the AHP and the Delphi method can be incorporated in carrying out design support evaluation. Madu et al (1991) presented a strategic framework for the development of information technology in Taiwan by combining Delphi and AHP. Khorramshahgol and Moustakis (1988) suggested that the Delphi method may be conducted prior to AHP so that the objectives under consideration in an analysis can be determined and the opinions of all decision makers can be incorporated into problem formulation. Chang et al (2007) used Delphi to define the evaluative criteria of an AHP matrix used to select an optimal performing machine in terms of precision, and establish a hierarchical framework. Lirn et al (2004) applied the AHP to reveal and analyse transhipment port selection by global carriers and conduct Delphi surveys among experts in order to narrow their number of attributes/criteria and sub-criteria. In the context of group decision making in AHP hierarchies Dyer and Forman (1992) suggested techniques such as Delphi have been developed in order to minimize or eliminate the dominance of a group by one or more of its members. Lai et al. (2002) used AHP for software selection called Multi-media Authorizing System. In this research, the participants agreed that AHP would be more acceptable over the Delphi method. Rong et al (2003) designed an AHP hierarchy to identify the key sources of all waste within a commercial enterprise and used the

Delphi method because he argued that it is faster and less expensive than other weight-assigning methods.

The application of the Delphi method in pooling expert judgement in design option assessment is an iterative forecasting procedure characterized by three features: anonymity, iteration with controlled feedback, and statistical response (Sii and Wang 2003). Sii and Wang (2003) described the Delphi method as a procedure of the following five steps:

1. Select the anonymous experts.
2. Conduct the first round of a survey.
3. Conduct the second round of a questionnaire survey.
4. Conduct the third round of a questionnaire survey.
5. Integrate expert opinions to reach a consensus.

Steps 3 and 4 are normally repeated until a consensus is reached on a particular topic. Results of the literature review and expert interviews can then be used to identify all common views of survey and simplify Step 2 to replace the tradition opening style survey. Simplifying the above process produces the modified Delphi method (Murry and Hammons 1995).

The Delphi method consists of many rounds of surveys until experts reach an agreement for their judgements. In the classical Delphi a statistical aggregation of group response is used for a quantitative analysis and interpretation of data (Skulmoski et al 2007), (Chen and Chen 2005). A simplified version of Delphi method that is suggested from many researchers is to average the experts opinions (Chang and Wang 2006), (Chen and Chen 2005), (Sii and Wang 2003), (Dyer and Forman1992), (Khorramshahgol and Moustakis 1988). By adopting this approach the Delphi method is used to extract the maximum amount of knowledge from a panel of experts. Suppose that in the first round the experts are in significant disagreement. Then the average results are given to each expert for reconsideration. The process is carried out on several rounds until the averages obtained from the last round are very close to each other. Therefore, the Delphi process is stopped and the experts accept the results obtained from the last round as a combined conclusion of experts' opinions.

4.2.4 Fuzzy Set Theory

The fuzzy concept can be embedded in Delphi Method by calculating the average weights of all the factors from the worst to the best degree based on the expert's experience. Many researchers (Chang et al 2000), (Chang and Wang 2006) suggested that Fuzzy and Delphi method could be applied to deal with the fuzzy relationship of the predicted items since the fuzzy number of each factor can explain clearly how independent variables are kept in the fuzzy forecasting models.

In this research possible methods to evaluate regulation performance were explored, however it is necessary to rely on data from judgements of experts and past experience. Hence, experts should evaluate the scorecards produced by the BSC method in order to verify their validity. Yet, experts may have to describe the given events in terms of vague and imprecise descriptors such as "likely" or "impossible". Such judgements may be more appropriate to analyse systems with incomplete information. Zadeh (1965) introduced the Fuzzy Set Theory in order to deal with linguistic difficulties while collecting data. Where there is a lack of data for analysis or where the level of uncertainty in safety data is unacceptably high, fuzzy set modelling may be effectively used as a useful alternative approach by maritime safety analysts to facilitate risk modelling and decision-making. It should be noted that degrees of truth are often confused with probabilities. However, they are conceptually distinct; fuzzy truth represents membership in vaguely defined sets, not the likelihood of some event or condition (Kim 2005). It should be emphasized that Fuzzy Sets are based on vague definitions of sets, not randomness.

Many academics have used the Fuzzy Set Theory for a variety of applications. Deng (1999) presented a fuzzy approach for tackling qualitative multi-attributable problems in a simple and straightforward manner in order to deal with human behaviour. Kulak et al (2005) proposed a multi-attribute comparison of information technology systems by using the Fuzzy Sets Theory. Liu et al (2005) proposed a framework for modelling the safety of an engineering system with various types of uncertainties using a fuzzy rule-based evidential reasoning approach.

The Fuzzy Set Theory has also been used to investigate specific maritime fields like flagging out (Haralambides and Yang 2002). Sii et al (2001) proposed a fuzzy-logic-based approach to qualitative safety modelling for marine systems. Pillay and Wang (2003) presented a new approach of failure mode and effects analysis. Kim et al (2006) presented an application of an approximate reasoning approach for fire risk in an engine room of a passenger ship. Sii et al (2004) developed a design-decision support framework for evaluation of design options/proposals by using a fuzzy-logic-based composite structure methodology. Arslan and Khisty (2005) developed a psychometric approach for making a more proper description of route choice behaviour in transportation systems.

In terms of regulations, Sii and Wang (2003) proposed a design-decision support framework for evaluation of design options/proposals using a fuzzy approach based on the concept that design should comply with the requirements given by the regulatory bodies. Similarly, the analysis by Haralambides and Yang (2002) consists of a role-based approach, having a more indirect impact on flag choice by affecting the regulatory and rating the environment of a shipowner. The Fuzzy Set Theory has been used extensively in the FSA context in evaluating the regulation process (Wang 2000). The framework proposed by Liu et al (2005) suggested that the fundamental parameters used to assess the safety level of an engineering system on a subjective basis can be modified to different requirements in codes and standards (e.g. safety/risk guidelines, regulations, laws, etc.) and the different aspects of an engineering system such as fire explosions, structure, safety system, etc.

For the proposed methodology, the triangular fuzzy numbers are used due to their simplicity. A fuzzy number is a special fuzzy set $\widetilde{M} = \{(x, \mu_{\widetilde{M}}(x)), x \in R\}$ where x takes its values on the real line $R: -\infty < x < +\infty$ and $\mu_{\widetilde{M}}(x)$ is a continuous mapping from R to the close interval [0, 1]. A triangular fuzzy number $\widetilde{M}$ can be defined by a triplet (a, b, c) as shown in Figure 4.3 and mathematically expressed as (Cheng et al 1999):

$$\mu_{\tilde{M}}(x)=\begin{cases} 0 & x<a \\ \dfrac{x-a}{b-a} & a\leq x\leq b \\ \dfrac{c-x}{c-b} & b\leq x\leq c \\ 0 & x>c \end{cases}$$

The addition, multiplication and reciprocal operations of the triangular fuzzy numbers are expressed below (Kwong and Bai 2003), (Chen and Chen 2005):

1. Fuzzy number addition $\oplus$

   $(a_1, b_1, c_1) \oplus (a_2, b_2, c_2) = (a_1+a_2, b_1+b_2, c_1+c_2)$ (6)

2. Fuzzy number multiplication $\otimes$

   $(a_1, b_1, c_1) \otimes (a_2, b_2, c_2) = (a_1a_2, b_1b_2, c_1c_2)$ (7)

3. Reciprocal fuzzy number

   $(a_1, b_1, c_1)^{-1} = (1/c_1, 1/b_1, 1/a_1)$ (8)

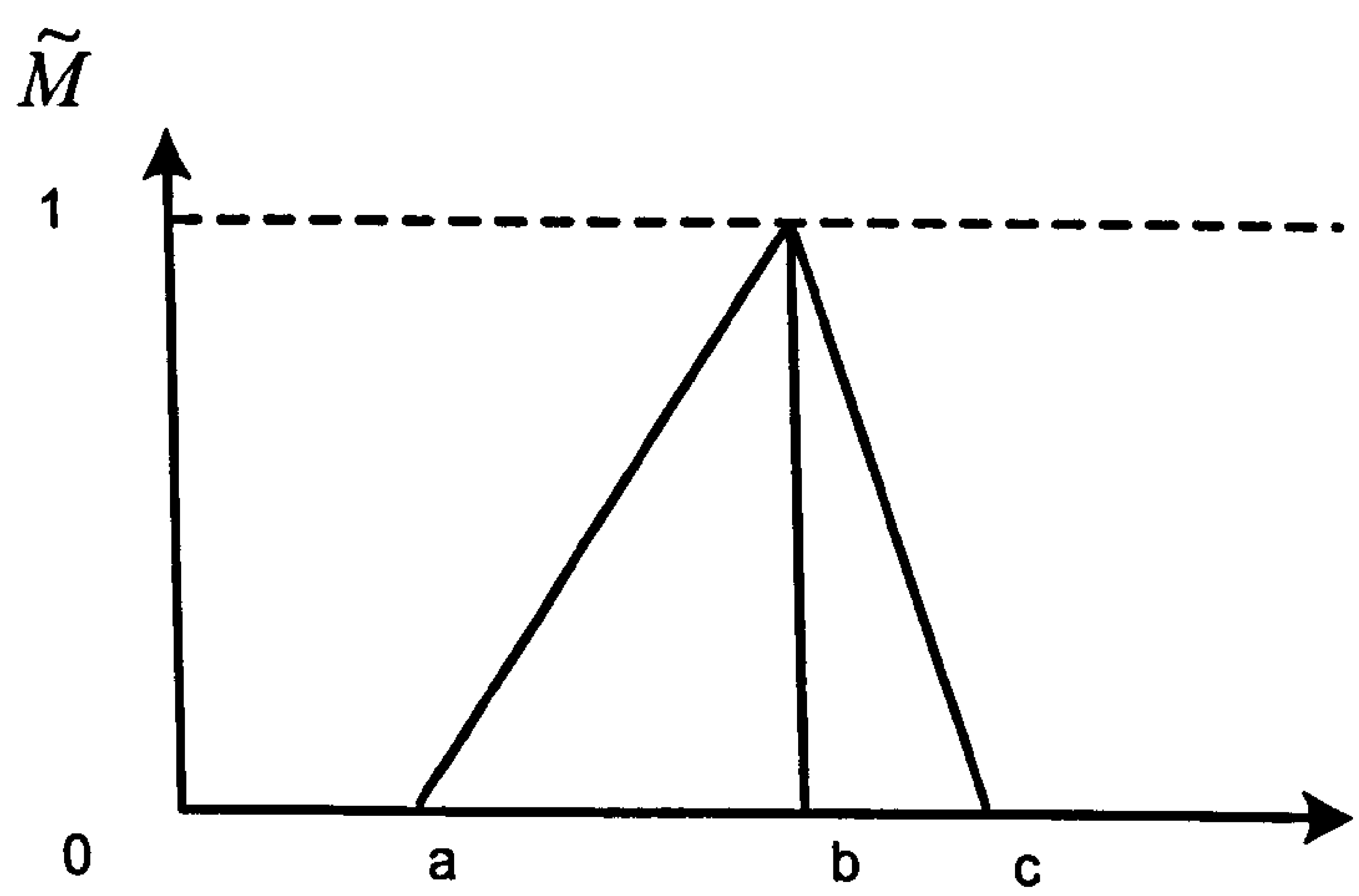

Figure 4.3. A Triangular Fuzzy Number $\tilde{M}$

For the fuzzy numbers a defuzzication process follows to obtain crisp numbers (*M_crisp*). The method to calculate the crisp number for a triangular fuzzy number, is to compute the centre of the fuzzy number's triangular area shown in Figure 4.4 (Wang and Parkan 2006):

$$M\_crisp = \frac{(b+a+c)}{3} \qquad (9)$$

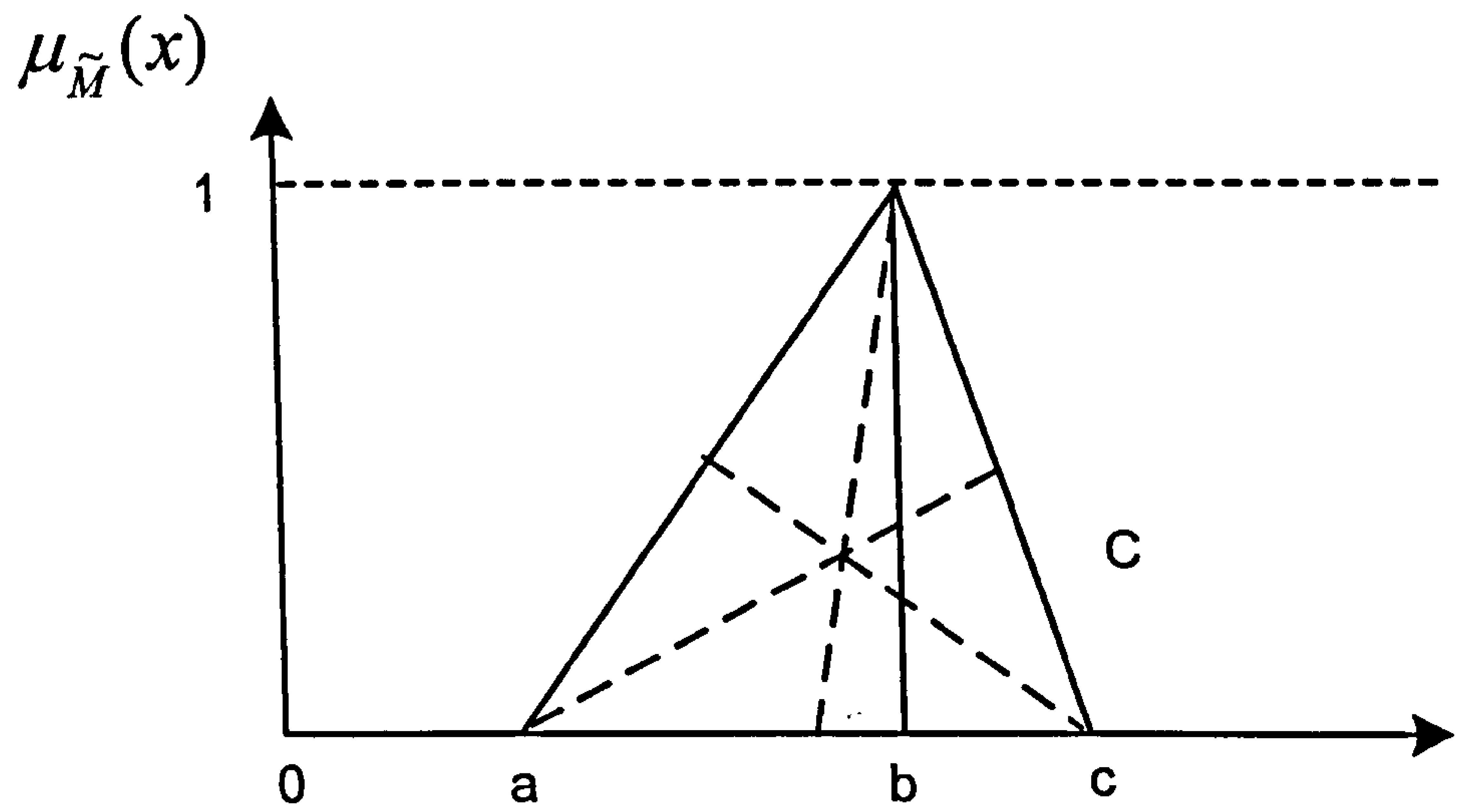

Figure 4.4. The Defuzzication of a Triangular Fuzzy Number

A main use of fuzzy sets is to evaluate linguistic terms that are used for gathering experts' judgements. However, it is arguable about which scale of linguistic numbers is the appropriate and how the fuzzy numbers should be determined respectively. To deal this problem some researchers used scales of their choice or they adopted scales from previous studies (Lee et al 2008), (Bozbura and Beskese 2007). The linguistic terms are used so that experts, who participate in a research project are able to express their thoughts by using words familiar to them. However, the linguistic terms that people use to express their feelings or judgments are generally vague (Efendigil et al 2008). It has been recognised that the words that a person is using are based more on his psychology than a mathematical order (Liu et al 2005). For instance, an individual may represent the linguistic term "equally important" with the triangular number (1,1,2) while another individual may choose the triangular number (1,1.5,2.5). Therefore, Ma et al (2007) highlighted the following issues when using linguistic terms:

1. Experts need to select linguistic terms for presenting their opinions by their preference. It is not demanded that all experts must use the same linguistic terms.
2. It is not required for all linguistic terms to be placed symmetrically and to have totally order. Therefore experts and decision makers have more independent right to present their opinions.

3. Each linguistic term should be treated as a whole and only concern on its determinacy and consistency.

4.3 Develop a Proposed Methodology

Aven and Korte (2003), and Chantelauve (2003) have discussed the need for the involvement of the private stakeholders as active players in order to support the regulation implementation process. The aim of this research is to design a method capable of evaluating the implementation performance of maritime regulations based on the stakeholders' balances between costs and benefits. The applicability of the method is tested in two stages, one for the shipping industry as a tool for the IMO and the other for a stakeholder, in particular a ship operator. Hence, it will be able to test the applicability of the method in the shipping industry. The application of this method will: a) design a tool to estimate the implementation performance of any maritime regulation before its enforcement to the industry and b) design a tool to estimate the performance of ship operators in terms of their compliance with a maritime regulation.

a. Stage 1

The size of the shipping industry is large and consists of many stakeholders. Thus, it is necessary to limit the number of the stakeholders that will be studied. The approach used, is that the stakeholders can be grouped according to their interests (MCA 1998) and from every group a representative stakeholder will be chosen for the purpose of the study. Hence, a representative sample of all main stakeholders will be studied. An appropriate framework for evaluating a regulation performance can be set by using the following six steps:

1. Set the hypothesis 1 that will be tested.
2. Identify the representative stakeholders within the shipping industry.
3. Identify the perspectives and measures that can evaluate the costs and the benefits of the implementation of a regulation for a representative stakeholder.

4. Develop a hierarchy for evaluating maritime regulations performance from the industry aspect.
5. Evaluate the weight of each stakeholder and its perspectives and rank them for their burden in the regulatory process.
6. Design an industrial tool capable of evaluating the implementation performance of the shipping industry in terms of compliance with a maritime regulation.

b. Stage 2

This Stage is to set an appropriate framework for evaluating a stakeholder's regulatory implementation by using the following six steps:

1. Set the hypothesis 2 that will be tested.
2. Identify the divisions of a stakeholder's organization.
3. Identify the perspectives and measures that can evaluate the costs and benefits of the implementation of a regulation for a department.
4. Develop a hierarchy for evaluating maritime regulations performance from a stakeholder's aspect.
5. Evaluate the weight of each division and its perspectives and rank them for their burden in the regulatory process.
6. Design a stakeholder's tool capable of evaluating the implementation performance of a stakeholder in terms of compliance with a maritime regulation.

4.3.1 Stage 1

In this stage a system for an evaluation of the shipping industry with regard to the implementation of a maritime regulation is developed. The supreme organisation that has the overall responsibility for the implementation of the regulations is the IMO. Therefore, the system is designed with the assumption that it will be used by the IMO.

4.3.1.1 Hypothesis 1

In Stage 1 the hypothesis 1 that is tested is if there is a greater probability that a regulation will be implemented adequately and in a logical time period if the benefits and costs generated are equally distributed among the industry's stakeholders. By measuring the benefits and costs of each stakeholder then it is possible to evaluate the possibility of this regulation to be implemented successfully. The evaluation result is stated as the performance of the regulation.

4.3.1.2 Identify the Representative Stakeholders within the Shipping Industry

The shipping industry is a complicated network composed of various stakeholders. The MCA (1998) proposed that stakeholders in the bulk sector can be grouped according to their interests, as it is shown in Table 4.2. However it is suggested that this list should be periodically revised. By using a sample of representative stakeholders from every group it is possible to estimate how the costs and benefits of a regulation will be distributed into the industry. The representative stakeholders used in this research are:

1. Flag State (S^1)
2. Coastal State (S^2)
3. Classification Society (S^3)
4. P&I (S^4)
5. Ship Operator (S^5)
6. Underwriter (S^6)
7. Marine Consultant (S^7)
8. Ship Builder (S^8)
9. Cargo Owner (S^9)
10. Crew members (S^{10})

In this chosen sample of representative stakeholders, two groups of stakeholders, media and consumers, are excluded since they do not participate directly in the sea trade. In addition, the P&I Club is distinguished from the group of underwriters because it has interests different from an underwriter's and should be studied separately. A P&I Club is likely to be exposed to higher financial responsibilities due to the third party liability cover that it offers. In contrast, the underwriters generally have financial responsibility to the value of the insured property (Aase 2007), (Goss

2003). Third party liabilities in case of pollution may include financial losses of big groups of people.

Table 4.2. The Stakeholders of Bulk Carrier Sector in Bulk Carriers
(Source MCA research project 422)

1. Owners & Operators
2. Staff and Support (Master, Crew, Crew Agency, Trade Unions, Families)
3. Hardware (Ship designers, Ship builders, Ship Repairers, Equipment Makers, Port Commercial (supply) Services)
4. Regulatory bodies (IMO, International Regulators, Port State, Flag State, Port Authority)
5. Non-Governmental Bodies and Pressure Groups (Classification Societies, Professional Bodies, Trade Associations, Training Establishments, Environmental Groups)
6. Cargo Group (Cargo Owner, Charterer(s), Terminal Operators, Stevedores)
7. Insurance Group (Hull & Machinery Underwriters, Cargo Underwriters, P & I)
8. Response Services (Rescue & Emergency Services, Salvors, Coastal State)
9. Media
10. Service Group (Legal Services, Marine Consultancy and Surveying Services, General Insurance)
11. Upstream and Downstream Group (Commercially or Geographically Dependant Region or States, Other Trading Nations, Suppliers, Consumers)

The authority and power that stakeholders can force to other stakeholders with regard to the regulatory process is a key issue in this research in order to assess their weighting in regulatory process. The current regulatory system poses a regulatory authority level among the stakeholders (Korte et al 2002). Korte et al (2002) suggested that the stakeholders are not exposed to the same level at hazards. They constructed a graph presenting the distance of stakeholders from a potential hazard in terms of physical distance and time, as it is shown in Figure 4.5. On the vertical axis, the stakeholders are posted according to their level of authority with the highest level on the top. On the horizontal axis, the stakeholders are posted regarding their distance to hazard where the right side is closer to the hazard.

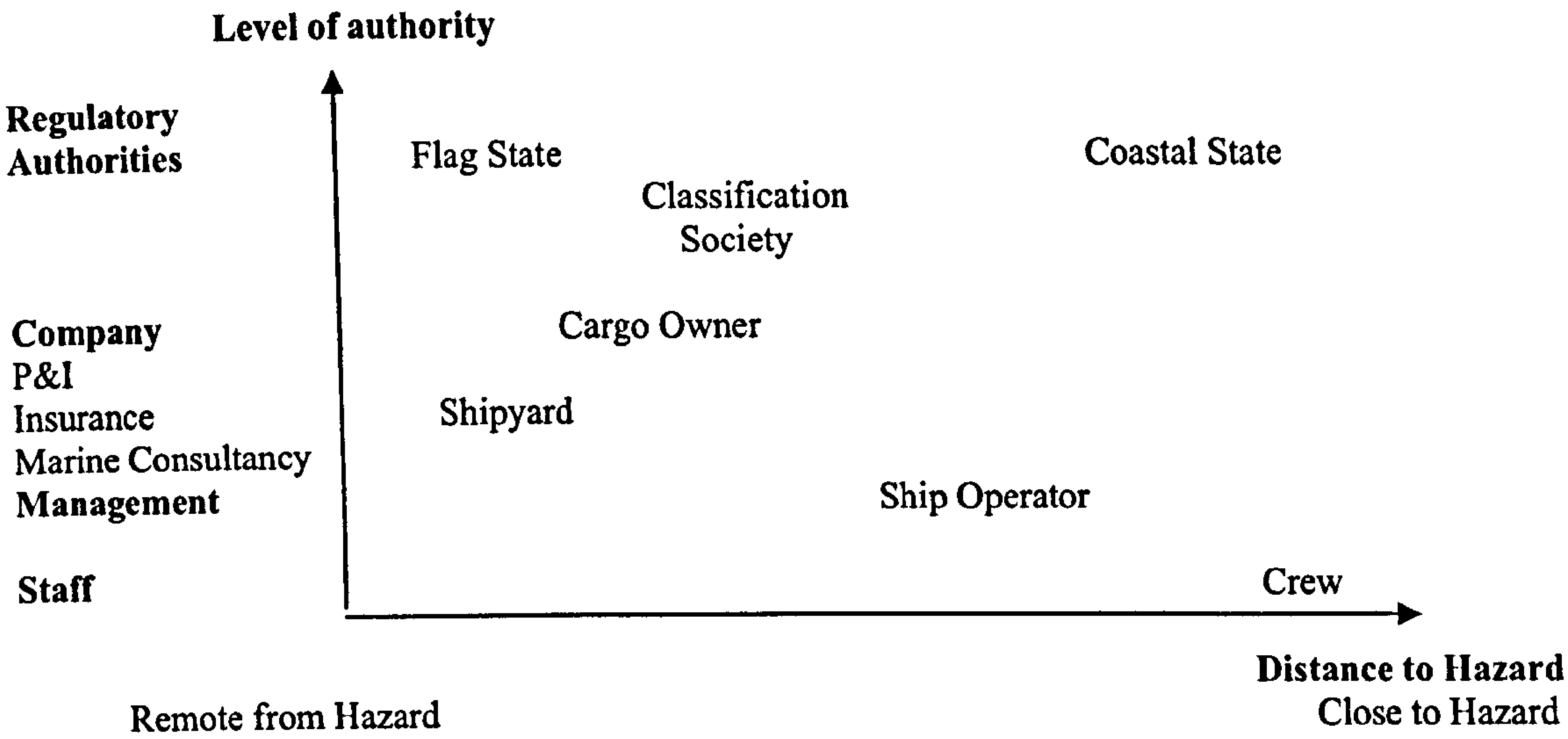

Figure 4.5. The Representative Stakeholders and their Distance from a Hazard

The validity of this system should be verified since it may be affected by the mutual commercial relationships of the stakeholders. For instance in all analyses it appears that cargo owners have higher level of regulatory authority than the ship operators do. Although this may generally be true, in a market cycle with high demand of ships the cargo owners may have to hire ships with lower standards than they would normally do.

4.3.1.3 Identify the Perspectives and Measures that can be used to Evaluate the Costs and the Benefits of the Implementation of a Regulation for a Representative Stakeholder

The benefits and costs of a stakeholder can be found in the initial four perspectives of the BSC method: financial, internal business, learning & growth and customer. However a generic BSC for the complicated shipping industry may not be effective. A structure of many scorecards for the shipping industry should be produced in order to identify the contribution and performance of every stakeholder in the maritime regulation implementation process. Every stakeholder's BSC should be addressed with appropriate perspectives and measures. It should be stressed that every representative stakeholder is unique, hence different measures should apply for every perspective. A proposed generic BSC for a stakeholder is shown in Table 4.3. The criteria for choosing measures are described in detail in Section 4.4.

Table 4.3. A Proposed Generic BSC for a Stakeholder

Stakeholder (S^c)	Perspectives (P_a^c)	Measures ($m_{b^a,c}^a$)
S^1	P_1^1 Financial Perspective	$m_{1^1,1}^1, m_{2^1,1}^1, \ldots, m_{g^1,1}^1$
	P_2^1 Customer Perspective	$m_{1^2,1}^2, m_{2^2,1}^2, \ldots, m_{g^2,1}^2$
	P_3^1 Internal Business Perspective	$m_{1^3,1}^3, m_{2^3,1}^3, \ldots, m_{g^3,1}^3$
	P_4^1 Learning & Growth Perspective	$m_{1^4,1}^4, m_{2^4,1}^4, \ldots, m_{g^4,1}^4$

where $m_{b^a,c}^a$ is a given measure, a is the indicator of measures' parent perspective (a=1,2,3,4 since there are only four perspectives), b^a is the indicator of measure ($b^a = 1^a, 2^a, \ldots g^a$), and c is the indicator of the stakeholder (c=1,2,...,d).

4.3.1.4 Develop a Hierarchy for Evaluating Maritime Regulations Performance from the Industry Aspect

The BSCs can be set as a hierarchy of priorities in a complex problem. In order to design a hierarchy one must set the appropriate Levels, which will simplify the solution of the perceived problem (Forman and Gass 2001). These Levels consist of an overall goal in Level 1, criteria that will lead to the goal in Level 2 and sub criteria in Level 3. A level 4 is also added in this hierarchy with measures for the sub criteria. At this stage of the research, the goal is the estimation of a maritime regulation performance. Level 2 is the representative stakeholders' performance. It is obvious that a stakeholder's willingness to contribute positive to any new maritime regulation enforcement greatly depends on the balance of its benefits towards its costs. The performance for any stakeholder can be evaluated by using the four perspectives of its BSC at Level 3. Every stakeholder's perspective must be addressed with its measures at Level 4. A graph of the proposed hierarchy structure is shown in Figure 4.6.

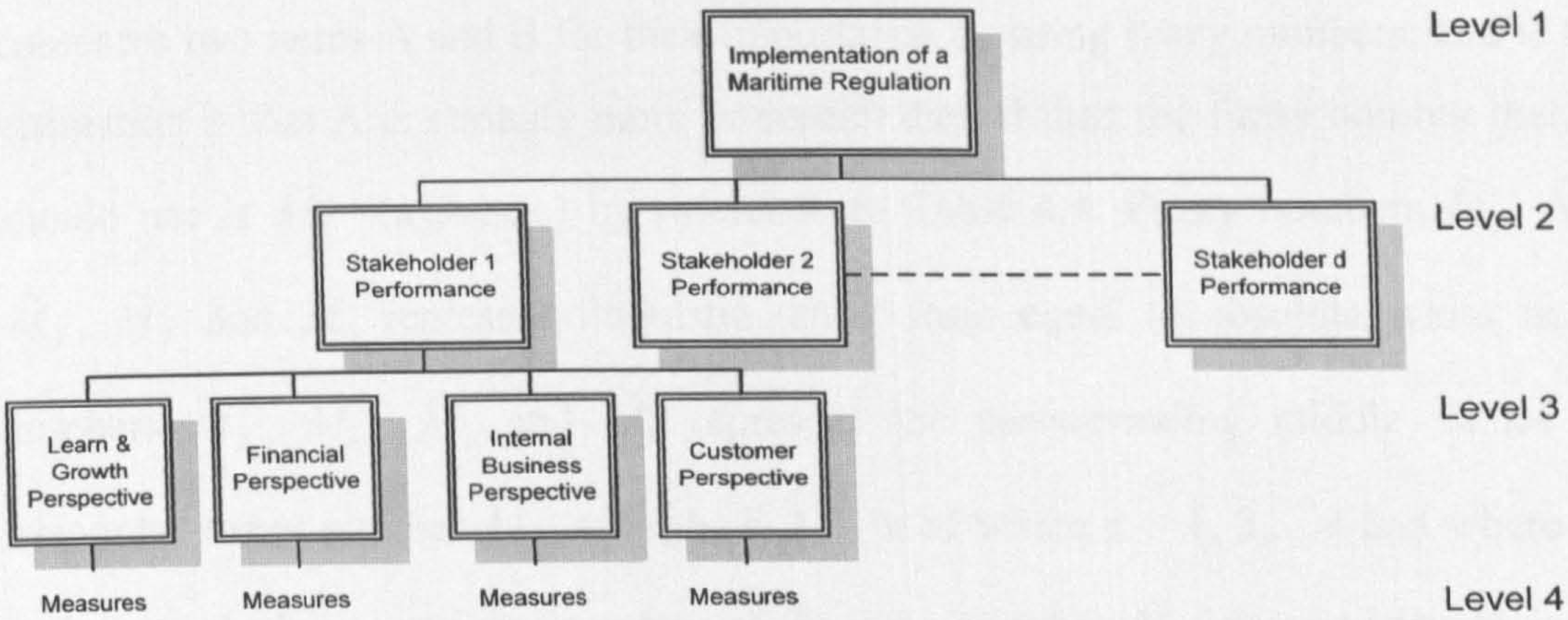

Figure 4.6. The Hierarchy Diagram for Estimating Maritime Regulations Performance from the Industry Aspect

4.3.1.5 Evaluate the Weight of Each Stakeholder and its Perspective and Rank them for their Burden in the Regulatory Process

Experts from industry are needed to test the validation of the created BSCs. To evaluate the BSCs the Delphi method is adopted where a group of experts is chosen to validate the BSCs' perspectives and measures through surveys (Sii and Wang 2003). Each expert receives the BSCs in a form of a questionnaire for evaluation and comments. The Delphi method consists of several rounds of surveys until experts reach an agreement for their judgements. However, it is often uncertain as to how many experts would be willing to voluntarily participate in such a lengthy process. In order to minimize the process the first round was replaced by the preparation of a questionnaire based on literature review. In the following rounds, the experts would have discretion either to agree or to reject any points of the questionnaires. In order to ensure the reliability of this survey the questionnaires were distributed to a range of experts working in various sectors of the shipping industry such as classification societies, shipping companies and consultants.

The experts rate the importance of each BSC item in a scale of five linguistic terms, where each term will correspond to a fuzzy number as it is shown in Table 4.4. Saaty justified that individuals find it easier to compare items in a 9-point scale (Harker and Vargas 1987). Therefore, the scale of 9 fuzzy numbers is used in accordance with the Saaty's scale in the AHP theory (Emshoff and Saaty 1981). For instance if one expert compares two items A and B for their importance by using fuzzy numbers, and if the estimation is that A is strongly more important than B then the fuzzy number that he should use is $\widetilde{M}_5$ =(a_5,b_5,c_5,) by reference to Table 4.4. Fuzzy numbers $\widetilde{M}_1$, $\widetilde{M}_3$, $\widetilde{M}_5$, $\widetilde{M}_7$ and $\widetilde{M}_9$ represent linguistic terms from equal to absolute while fuzzy numbers $\widetilde{M}_2$, $\widetilde{M}_4$, $\widetilde{M}_6$ and $\widetilde{M}_8$ represent the corresponding middle values. A triangular fuzzy number $\widetilde{M}_z$, = (a_z,b_z,c_z,) is used where z = 1, 2,...,9 and where a_z and c_z are the lower and upper values of the fuzzy number $\widetilde{M}_z$, respectively. b_z is the middle value of the fuzzy number $\widetilde{M}_z$ with a membership value equal to 1.

Experts are requested to determine the membership functions of fuzzy numbers through the questionnaire. Initially every expert is asked to evaluate the boundaries of a linguistic term with two values in a range from 1 to 9 where the lower value and the upper value are a_z and c_z respectively. The expert then has to define, in his opinion, the most probable value that represents the linguistic term in question. This most probable value will be b_z. By using this method, the experts' opinions for every linguistic term can be expressed in fuzzy triangular numbers.

According to expert opinions (E_i) each linguistic term should be represented by a triangular number $\widetilde{M}_z$ (z=1,2,..,9) where the value that is nearest to his understanding for that term will be the middle value b_z. After the last round of the Delphi method each expert will have concluded to a set of triangular numbers. It may be very difficult for those experts to choose the same set of numbers. Therefore, the final sets each expert will be averaged in order to determine the appropriate linguistic terms. The average of r experts' opinions, $E_{\widetilde{M}_z}$ will be used to determine the fuzzy number for each linguistic term:

$$E_{\widetilde{M}_z} = \frac{\sum_{i=1}^{r} E_i}{r} \qquad (10)$$

Table 4.4. The 9-Point Scale of AHP with Fuzzy Numbers

Intensity of Membership Importance	Fuzzy Number	Definition	Membership Function
1	$\widetilde{M}_1$	Equal Importance	$(a_1,b_1,c_1,)$
2	$\widetilde{M}_2$	Equal to Weak Importance	$(a_2,b_2,c_2,)$
3	$\widetilde{M}_3$	Weak Importance	$(a_3,b_3,c_3,)$
4	$\widetilde{M}_4$	Weak to Strong Importance	$(a_4,b_4,c_4,)$
5	$\widetilde{M}_5$	Strong Importance	$(a_5,b_5,c_5,)$
6	$\widetilde{M}_6$	Strong to Demonstrated Importance	$(a_6,b_6,c_6,)$
7	$\widetilde{M}_7$	Demonstrated Importance	$(a_7,b_7,c_7,)$
8	$\widetilde{M}_8$	Demonstrated to Extreme Importance	$(a_8,b_8,c_8,)$
9	$\widetilde{M}_9$	Extreme Importance	$(a_9,b_9,c_9,)$

After the evaluation of the BSCs by the experts, the next step is to rank the scorecards perspectives and measures according to their weights of importance. By making pairwise comparisons of the stakeholders' implementation performance in Level 2, their relevant weights in the maritime regulation implementation process can be evaluated. By ranking the elements of Level 3 in terms of their importance, it is possible to identify which perspectives are more important for a stakeholder. The pairwise comparisons in Level 4, among measures of a stakeholder, can show the weight of each measure. The significance of measures' weights is important for the evaluation of their parent perspectives.

It may be expected that due to the size of the proposed hierarchy, a large number of pairwise comparisons should take place. Some researchers suggest that it is not necessary to make all calculations because the importance of an element can be identified with a selective number of comparisons (Harker 1987), (Chan 2006). A very popular method used is the one established by Harker (1987). However even by using Harker's method the pairwise comparisons required after the Level 3 will still be many in number. Furthermore, it is very time consuming for experts to make pairwise comparisons for Level 4. Therefore, the measures' weights are not calculated in this research. However, if the unequal weights of measures in Level 4 are required in some cases by the stakeholders, the model is still applicable to use the procedure similar to the one for calculating the weights in Levels 2 and 3.

The purpose of this research is not merely to rank the elements of the proposed BSCs but to create a performance management system that can regularly be updated with new feedbacks. Furthermore, it should be emphasized that the BSCs are designed for industrial use. It is assumed that the industrial personnel are not familiar with fuzzy numbers. Therefore, the feedbacks will be entered in the system as values of the measures. However, the values of some measures may be different such as number of accidents or amount of money. Thus, it is necessary to normalise these values in the same scale e.g. 0 to 10. By adopting this approach, the input of the system will be the relative success of each measure in terms of achievement. Then by using the weights of the parent perspectives it will be possible to calculate the performance of each stakeholder and consequently the industry.

4.3.1.6 Design an Industrial Tool Capable of Evaluating the Implementation Performance of the Shipping Industry in Terms of Compliance with a Maritime Regulation

The calculated weights of previous steps may be used to design tools capable of evaluating the implementation performance of a maritime regulation. According to this approach, the initial BSCs should be modified in order to include the weights of their perspectives' and measures' values. Therefore, every time that a measure of a BSC is filled it will then be possible to calculate its effect in the regulatory process. An industrial tool can be designed by using the five steps below:

Step 1: Rate the measures $Rm^{a}_{b^a,c}$ of each BSC in a scale with values from 0 to 10.

Step 2: Calculate each perspective rate RP^c_a by multiplying its weight wP^c_a with the average rate of its measures (Equation 11).

Step 3: Sum the perspectives rates of each stakeholder to find his performance S^c (Equation 12).

Step 4: Multiply a stakeholder's weight wS^c with its performance pS^c to find its rate RS^c (Equation 13).

Step 5: Sum the stakeholders rates RS^c to calculate the total rate TR (Equation 14).

$$RP_a^c = \frac{1}{g^a}\sum_{b^a=1}^{g^a} Rm_{b^a,c}^a \times wP_a^c \qquad (11)$$

$$pS^c = \sum_{a=1}^{4} RP_a^c \qquad (12)$$

$$RS^c = pS^c \times wS^c \qquad (13)$$

$$TR = \sum_{c=1}^{d} RS^c \qquad (14)$$

Equations 11 to 14 can be further developed to Equation 15 below:

$$TR = \frac{1}{g^a}\sum_{c=1}^{d}\sum_{a=1}^{4}\sum_{b^a=1}^{g^a} Rm_{b^a,c}^a \times wP_a^c \times wS^c \qquad (15)$$

The rating of each BSC measure should be in a scale with values from 0 to 10. An example of definitions and their rates is shown in Table 4.5. Then these rates will be used to calculate the total rate of a stakeholder. The rates should be based on the linguistic terms as defined in the five categories of Table 4.5 and by using experts' opinions.

Table 4.5. An Example of Measures Rates

Rate	Definition
8-10	Very High Performance
6-8	High Performance
4-6	Medium Performance
2-4	Low Performance
0-2	Very Low Performance

4.3.2 Stage 2

In Stage 2, the applicability of the method is extended in the case of a stakeholder. Hence, it is not necessary to describe in detail the method as in Stage 1, but rather to highlight the important points for every step of the method when it is used for the stakeholders' case.

4.3.2.1 Hypothesis 2

The hypothesis 2 is that it is very challenging for a small ship operator to comply with a newly introduced maritime regulation. The ship operator is chosen as an example of a stakeholder to show the applicability of the methodology in the main divisions of a ship operator's company by using BSCs. A particular interest is given on the ability of a small ship operator to comply with maritime regulations.

4.3.2.2 Identify the Divisions of a Stakeholder's Organisation

A stakeholder is running his daily business in a complicated business and regulatory environment. Therefore, the organization structure of a stakeholder may consist of many various divisions. A ship operator's company can be divided into divisions with specific activities. Each ship operator is using a different structure. Therefore, the chosen model is based on a typical medium sized company of a ship operator in Greece. The divisions' significances are verified by the literature review as shown in Table 4.6 (Chu and Liang 2001), (Lyridis 2005), (Panayides 2003), (Panayides and Cullinane 2002), (Jensen and Randoy 2002, 2006), (MCA 1998). Although the managing director and the ship are not divisions they have been added to the proposed list because they are essential parts a ship operator's organisation.

4.3.2.3 Identify the Perspectives and Measures that can Evaluate the Costs and Benefits of the Implementation of a Regulation for a Stakeholder

The designed BSCs, which are displayed in Table 4.7, are based on the fact that every division must contribute to the goal, which is the effective implementation of maritime regulations by the ship operator. The four perspectives are used in order to describe how every department should achieve the goal. However, the measures of every department will vary considerably since the aims, targets and operation of divisions are usually very different. The criteria for choosing the appropriate measures are discussed in Section 4.4.

Table 4.6. The Organization Structure of a Ship Operator by Divisions and their Activities

Division	Activities
1. Managing Director	Overall management, hiring employees, ships purchase and scrapping
2. Operation Department	Operation and performance of a ship in accordance to its commercial and legal obligations
3. Technical Department	Operation, performance and maintenance of the engineering and technical systems of a ship, dry-docking and repairs
4. ISM Department	Safety management, implementation of safety and pollution regulations
5. ISPS Department	Implementation of security regulations
6. Chartering Department	Chartering and charter compliance
7. Accounting Department	Budgetary control
8. Crew Department	Recruitment and manning of ships
9. Supply Department	Supply of deck stores, provisions and paints inquiries
10. Ship	Operate of ship with the highest level of safety in accordance with the company's stated principles, policies and objectives

Table 4.7. A Detailed BSC for a Stakeholder Including his Divisions

Division (D_u^c)	**Perspectives ($P_{a,u}^c$)**	**Measures (m_{b^a,c^u}^a)**
D_1^1	$P_{1,1}^1$ Financial Perspective	$m_{1^1,1^1}^1, m_{2^1,1^1}^1, \ldots, m_{g^1,1^1}^1$
	$P_{2,1}^1$ Customer Perspective	$m_{1^2,1^1}^2, m_{2^2,1^1}^2, \ldots, m_{g^2,1^1}^2$
	$P_{3,1}^1$ Internal Business Perspective	$m_{1^3,1^1}^3, m_{2^3,1^1}^3, \ldots, m_{g^3,1^1}^3$
	$P_{4,1}^1$ Learning & Growth Perspective	$m_{1^4,1^1}^4, m_{2^4,1^1}^4, \ldots, m_{g^4,1^1}^4$

where m_{b^a,c^u}^a is a given measure, a is the indicator of measures parent perspective (a=1,2,3,4 since there are only four perspectives), b^a is the indicator of measure ($b^a = 1^a, 2^a, \ldots g^a$), u is the indicator of the relevant divisions (u=1,2,3,..,l) and c is the indicator of the stakeholder ($c^u = 1^u, 2^u, \ldots d^u$).

4.3.2.4 Develop a Hierarchy for Evaluating Maritime Regulations Implementation Performance from a Stakeholder's Aspect

Each division contributes to the operation of its organisation with a unique way. However, the divisions of an organisation may not be of equal weight. Following the steps of the methodology a diagram will be designed dividing the BSC into four levels as shown in Figure 4.7. The hierarchy designed for the shipping industry can be extended as it is shown in Figure 4.8 in order to include a detailed evaluation of the implementation performance of a stakeholder. It should be emphasised that this hierarchy is designed as a more detailed analysis for a ship operator than the Stage 1 as it is shown in Figure 4.8. By making pairwise comparisons of the divisions in Level 6, their relevant weights in the maritime regulation implementation process can be estimated. By ranking the elements of Level 7 in terms of their importance, it is possible to identify which perspectives are more important for a division. For the same reasons for Level 4 at Stage 1 the pairwise comparisons in Level 8, among measures of a division's perspective, will not be carried out. However, the identification of such measures is useful in order to describe how a stakeholder can achieve each perspective and consequently to successfully implement a new regulation.

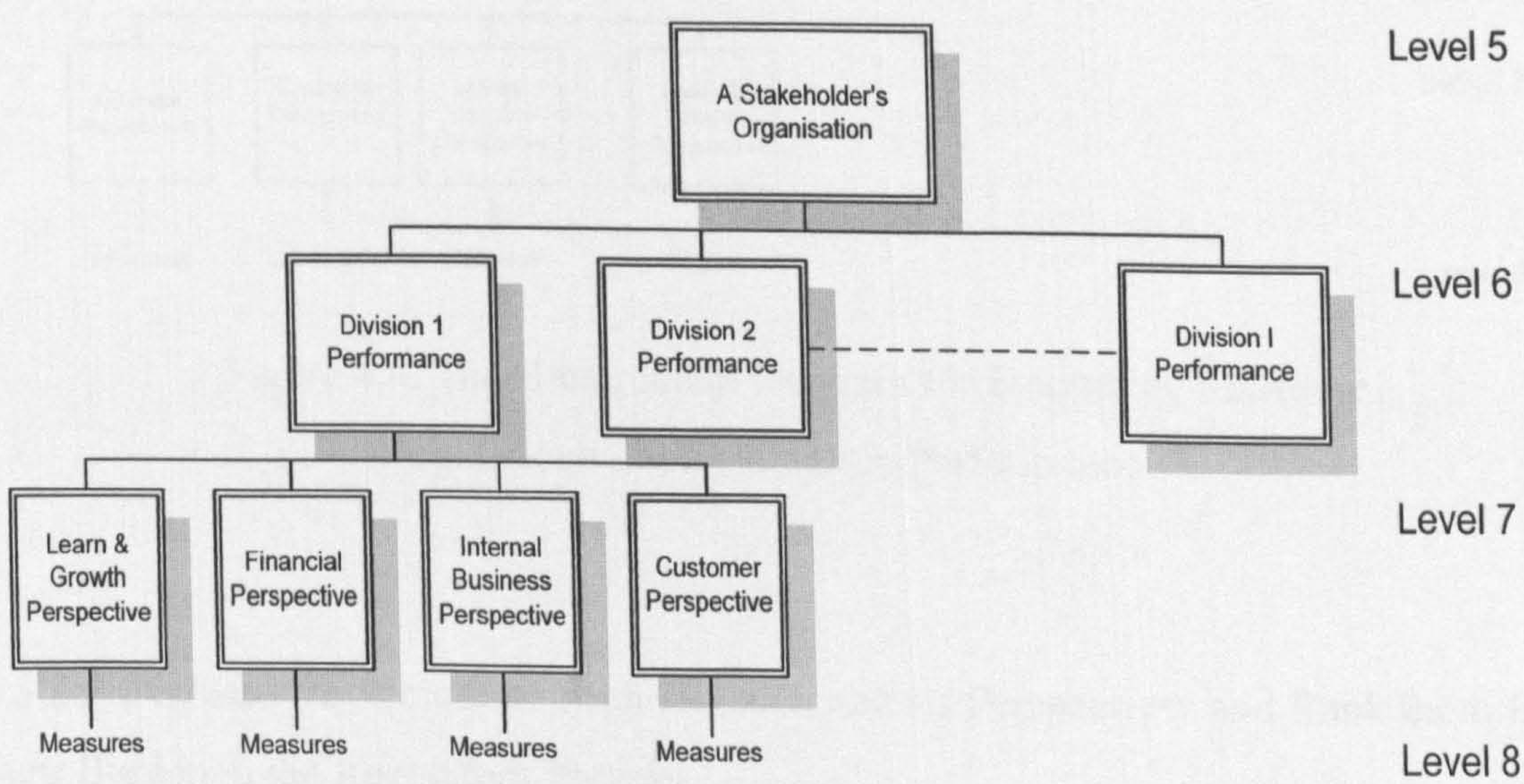

Figure 4.7. The Hierarchy Diagram for Evaluating Maritime Regulations Performance from the Stakeholder Aspect

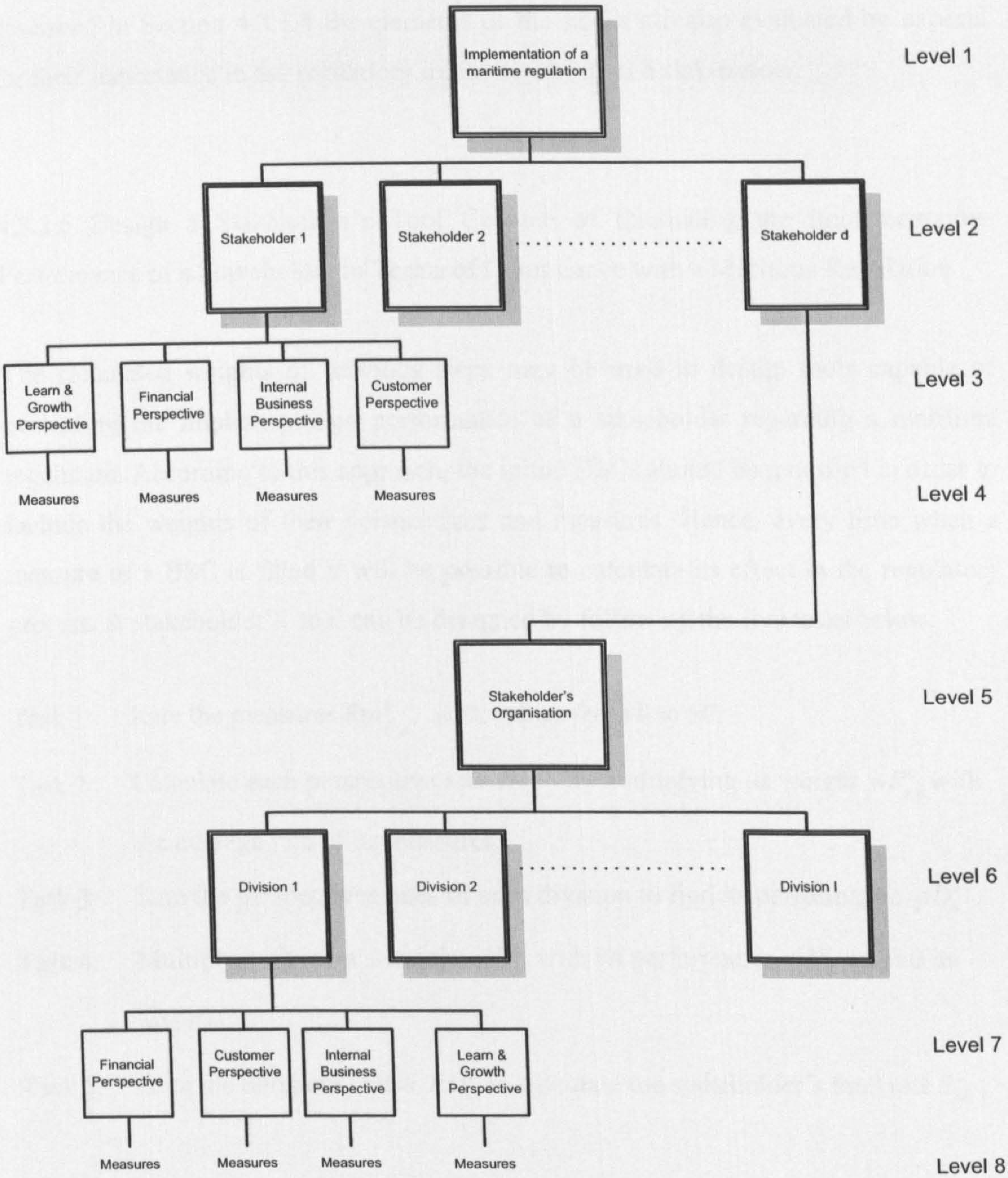

Figure 4.8. The Hierarchical Diagram for Evaluating Maritime Regulations Implementation Performance

4.3.2.5 Evaluate the Weight of Each Division and its Perspectives and Rank them for their Burden in the Regulatory Process

Experts through survey should validate the BSCs containing the perspectives and measures for a detailed analysis of stakeholders. By adopting the same method described in Section 4.3.1.4 the elements of the BSCs are also evaluated by experts for their importance in the regulatory implementation of a stakeholder.

4.3.2.6 Design a Stakeholder's Tool Capable of Evaluating the Implementation Performance of a Stakeholder in Terms of Compliance with a Maritime Regulation

The calculated weights of previous steps may be used to design tools capable of evaluating the implementation performance of a stakeholder regarding a maritime regulation. According to this approach, the initial BSCs should be modified in order to include the weights of their perspectives and measures. Hence, every time when a measure of a BSC is filled it will be possible to calculate its effect in the regulatory process. A stakeholder's tool can be designed by following the five tasks below:

Task 1: Rate the measures $Rm^{a}_{b^{a},c^{u}}$ with values from 0 to 10.

Task 2: Calculate each perspective rate $RP^{c}_{a,u}$ by multiplying its weight $wP^{c}_{a,u}$ with the average rate of its measures.

Task 3: Sum the perspectives rates of each division to find its performance pD^{c}_{u}

Task 4: Multiply a division's weight wD^{c}_{u} with its performance pD^{c}_{u} to find its rate RD^{c}_{u}.

Task 5: Sum the divisions' rates RD^{c}_{u} to calculate the stakeholder's total rate S^{c}_{TR}.

The above procedure can be presented by the following equations:

$$RP^{c}_{a,u} = \frac{1}{g^{a}} \sum_{b=1}^{g^{a}} Rm^{c}_{b^{a},c^{u}} \times wP^{c}_{a,u} \tag{16}$$

$$pD^{c}_{u} = \frac{1}{g^{a}} \sum_{a=1}^{4} \sum_{b=1}^{g^{a}} Rm^{a}_{b^{a},c^{u}} \times wP^{c}_{a,u} \tag{17}$$

$$RD^{c}_{u} = pD^{c}_{u} \times wD^{c}_{u} \tag{18}$$

$$S^{c}_{TR} = \frac{1}{g^{a}} \sum_{u=1}^{l} \sum_{a=1}^{4} \sum_{b=1}^{g^{a}} Rm^{a}_{b^{a},c^{u}} \times wP^{c}_{a,u} \times wD^{c}_{u} \tag{19}$$

The rating of each BSC measure should be valued from 0 to 10. The definitions of rates are shown in Table 4.5. Then these rates will be used to calculate the total rate of a stakeholder.

4.4 General Principles for Designing a BSC

A main aim of the methodology is to provide a list of significant items that should be gradually followed by any stakeholder in order to achieve effective implementation. This list should include vital functions of a company such as implementation procedure, cost assessment, availability of resources and monitoring.

4.4.1 The Size of a BSC

The architects of the BSC method (Kaplan and Norton 1996a, b) suggested that a company should not use an excessive number of measures in their BSCs. An upper limit of twenty-five measures per BSC may assist managers to keep a focus on their company's goal. The same approach was followed in this research to every stakeholder's scorecard.

4.4.2 Proposed Measures

Kaplan and Norton (1996a, b), (2000), (2004) noted that many companies are using similar measures in order to evaluate their perspectives. A list of these common identified measures from previous BSC applications is shown in Table 4.8. Although these measures have already been validated in other industries and they address the main objectives of many companies, they should be used with caution when describing any cost or benefit of a stakeholder in the shipping industry. The initial measures are modified into the more appropriate ones for the shipping industry as proposed in Table 4.9 for financial, customer and learning and growth perspectives. The measures of internal business are discussed in the following section.

Table 4.8. Identified Measures from Previous BSC Applications

Financial Perspective	Customer Perspective	Internal Business Perspective	Learning & Growth Perspective
Total profit	Product quality	Manufacturing lead time	Human capital
Total revenue	Product price	Yield	Information capital
Sales growth	Range of products and services	Inventory accuracy	Organizational capital
Total cost	Customer response time	Material inventory	
Delivery cost	On-time delivery	Material stock-out	
Inventory carrying cost	Finished goods inventory	New product time to market	
Cost per unit produced	Finished goods stock-out	Percentage of sales from new products	
Cash flows	Repeat and new customer sales		
	Order fill rate		
	Corporate image		
	Reputation		

Table 4.9. Proposed Measures for the Implementation of a Maritime Regulation

	Definition of Measures
Financial Perspective	
Profit	The maximum benefit that can be acquired from a regulation implementation.
Revenue	The benefit that can be acquired from a regulation implementation.
Cost	The cost that can be acquired from a regulation implementation.
Use of assets	The required resources that will be needed for a regulation to be implemented.
Customer Perspective	
Productivity	The operational efficiency that can be achieved from a regulation implementation.
Competitiveness	The commercial advantage that can be achieved from a regulation implementation.
Quality	The increased quality level that can be achieved from a regulation implementation.
Reputation	The increased organization image that can be achieved from a regulation implementation.

Learning & Growth Perspective	
Human capital	The required skills, talent, and knowledge that a company's employees should possess in order to implement a new regulation.
Information capital	The required company's databases, information systems, networks, and technology infrastructure.
Organizational capital	The company's culture, its leadership, how aligned its people are with its strategic goals, and employees' ability to share knowledge.
Innovation	The ability of people to produce new practices.

4.4.3 Internal Business Measures

Every maritime regulation was introduced by the IMO to enhance safety at sea and/or to protect the environment. Any failure to effectively implement a maritime regulation may have adverse effect in terms of safety, pollution and business damage for the violated party. Consequently, all the requirements of a regulation should be implemented since partial implementation of a regulation may generate grounds for possible accidents. For instance, a stakeholder's failure to implement a regulation may lead to severe consequences such as loss of human lives and/or environmental disasters. Therefore, the measures that are proposed to address the internal business perspective consist of the basic principles of crisis management.

The concept of crisis management is well known in the shipping industry, since it is used in various shipboard contingency plans, as it is proposed by the IMO (IMO 1997). The internal business measures are based on two main sources. The first one is the crisis management proposed by Watkins and Bazerman (2003, 2004) which is the only contribution dealing with three main phases of a crisis management plan. These phases consist of identification, assessment and management (Kramer 2005), (Pollard and Hotho 2006). The second source is the IMO resolution for contingency planning for ships (IMO 1997), which is the nearest approach of crisis management in the shipping industry.

A third source that is used is the ABS guidance notes on the investigation of marine incidents (ABS 2005), which provides a detailed analysis of how a marine incident can be prevented and what corrective actions should be followed in terms of efficient management. The guidance includes also principles of an effective emergency preparedness planning. Therefore, it is used as an additional source of information. Among these sources four common stages of a crisis plan that emerge are risk analysis, planning, training and review. Therefore, the common stages are proposed as the measures for the perspective of internal business are shown in Table 4.10.

The proposed measures of the internal business that are chosen consist of the basic principles of crisis management as these appear. Initially a risk analysis is carried out to assess any potential hazards that may be generated by the implementation of a maritime regulation. Then planning is necessary to be carried out in order to minimise the identified hazards by following acceptable practices. A well-established training schedule, which should include drills, can verify the alertness of the employees. Finally, a review process can identify any possible weakness of the crisis management procedure. The proposed measures and their definitions are shown in Table 4.11.

Table 4.10. Comparison of Crisis Management Plans

Watkinson & Bazerman	ABS	IMO	Proposed Measures
Planning	Risk analysis	Risk analysis	Risk analysis
Emergency Response Planning	Policy	Response tasks	Planning
Combination Plans	Implementation	Resources & communication lines	Training
Responsibility	Documentation	Planning	Review
Set alert indications	Training	Combination plans	
Communications	Review	Education	
Communication methods		Review & update	
Backup resources			
Drill			
Post crisis review			

Table 4.11. Definitions of the Internal Business Measures

Internal Business Perspective	Definitions
Risk analysis	The risk assessment of potential difficulties that a new introduced regulation can produce during its implementation.
Planning	The design of an appropriate documented policy that will provide detailed notes regarding the implementation of a regulation, including communications and response plans.
Training	The appropriate education of all employees of the organization including schools and drills.
Review	The all-appropriate techniques to verify the good implementation of new planning including monitoring, supervision, inspection and feedbacks.

4.4.4 BSCs Measures and their Objectives

In a BSC it is necessary to define the measures, which are used to evaluate and monitor the progress of their parent perspectives. Every measure should address an objective, which is a statement describing that the specific things must perform well if the strategy is successfully implemented. The objectives should act as a bridge from the high level strategy to the specific performance measures that is used to determine the progress toward overall goals (Niven 2002).

In this research, it is suggested that a measure should be self defined by including its objective. Therefore, an unfamiliar user with the proposed methodology or the tools by reading each measure should understand the purpose and scope of this measure as well. The term measure is used for specific measure while the term generic measure refers to initial measures such as profit, planning etc.

4.4.5 The Concept of Measurement Quantity in a BSC

Each measure of the BSC should be specified with a measurement quantity such as money, hours, human errors etc. The measurement quantity for the internal business process measures may be estimated by taking into account the required hours and money spent to carry out the process. Each measure of internal business should address two basic elements: the time that is necessary to carry out the appropriate tasks and the cost of each task. For instance, a risk analysis that can be carried out by a single middle level manager within a specific period of time should be measured as a smaller effort than a risk analysis carried out by several high level managers in the same period. Hence, the ratio between money and hours is proposed to evaluate the measures of the internal business perspective. In Table 4.12 a list of proposed measures for the implementation of a maritime regulation and the measurement quantity is displayed.

Table 4.12. Proposed Measures for the Implementation of a Maritime Regulation

Generic Measure	Measure	Measurement Quantity
Financial Perspective		
Profit	Increase revenues from new services and products.	Amount of new revenues.
Revenue	Increase existing revenues.	Amount of revenues.
Cost	Reduce direct and indirect costs.	Amount of cost reduction.
Use of Assets	Keep the expenditure cash flow minimum.	Amount of cash expended
Customer Perspective		
Productivity	Increase services and products sales.	Number of new sales.
Competitiveness	Increase commercial advantage.	Number of new customers.
Quality	Increase the quality of services and products.	Number of management deficiencies.
Reputation	Increased organization image.	Number of claims.
Learning & Growth Perspective		
Human capital	Minimize the need to hire employees with high skills, talent and knowledge.	Number of new vacancies required to fulfil new requirements.
Information capital	Minimize the need to adopt new information systems, networks and technology infrastructure.	Number of new IT applications.
Organizational capital	Improve company's culture, its leadership, how aligned its people are with its strategic goals, and employees' ability to share knowledge.	Number of human errors.
Innovation	Increase the ability of people to produce new practices.	Number of new practices adopted by the organisation.

Internal Business Perspective		
Risk analysis	Reduce the efforts needed to carry out risk assessment of the potential difficulties that a newly introduced regulation can produce during its implementation.	Money/hours.
Planning	Reduce the efforts needed to design an appropriately documented policy with detailed procedures regarding the implementation of a regulation, including communication and response plans.	Money/hours.
Training	Reduce the efforts needed for appropriate education of all employees of the organization through training and drills.	Money/hours.
Review	Reduce the efforts needed to verify the good implementation of new planning including monitoring, supervision, inspection and feedbacks.	Money/hours.

4.4.6 The Link of Perspectives and their Measures

It is essential to present how the proposed system of perspectives and measures should be used regarding regulation implementation. As shown in Figure 4.9, the tiers indicate the main direction that should be followed gradually. The initial perspective at Tier 1, in the graph, is learn & growth, which contains all the existing management knowledge, information systems and represents the human resources and information technology. By starting from the base going upwards, the existing knowledge, which is the innovation, should lead to an effective information management system capable of monitoring all the company activities. Tier 2 is the internal business perspective, which represents the procedure of implementing a regulation. Tier 3 is the customer perspective, which indicates the results of a regulation in business practises. Customer satisfaction will increase if there is more production and better quality. An increase in quality and productivity will increase competitiveness of the company and consequently will improve its reputation. Tier 4 is the financial perspective, which indicates the economic achievements or losses from the implementation of a regulation. In Tier 4 the increase or loss from the existing assets value of the company should be followed from cost reduction to profit. It should be stressed that the profit of the company is the factor that will contribute the most to the future survival of the company. Tier 4 is not the end of the process but the end of a cyclic process. The process is repeated from Tier 1 where part of the profit will be reinvested to develop the knowledge and experience that was acquired through the process. By adopting the past experience in the existing procedures, the company will gain innovation for further growth.

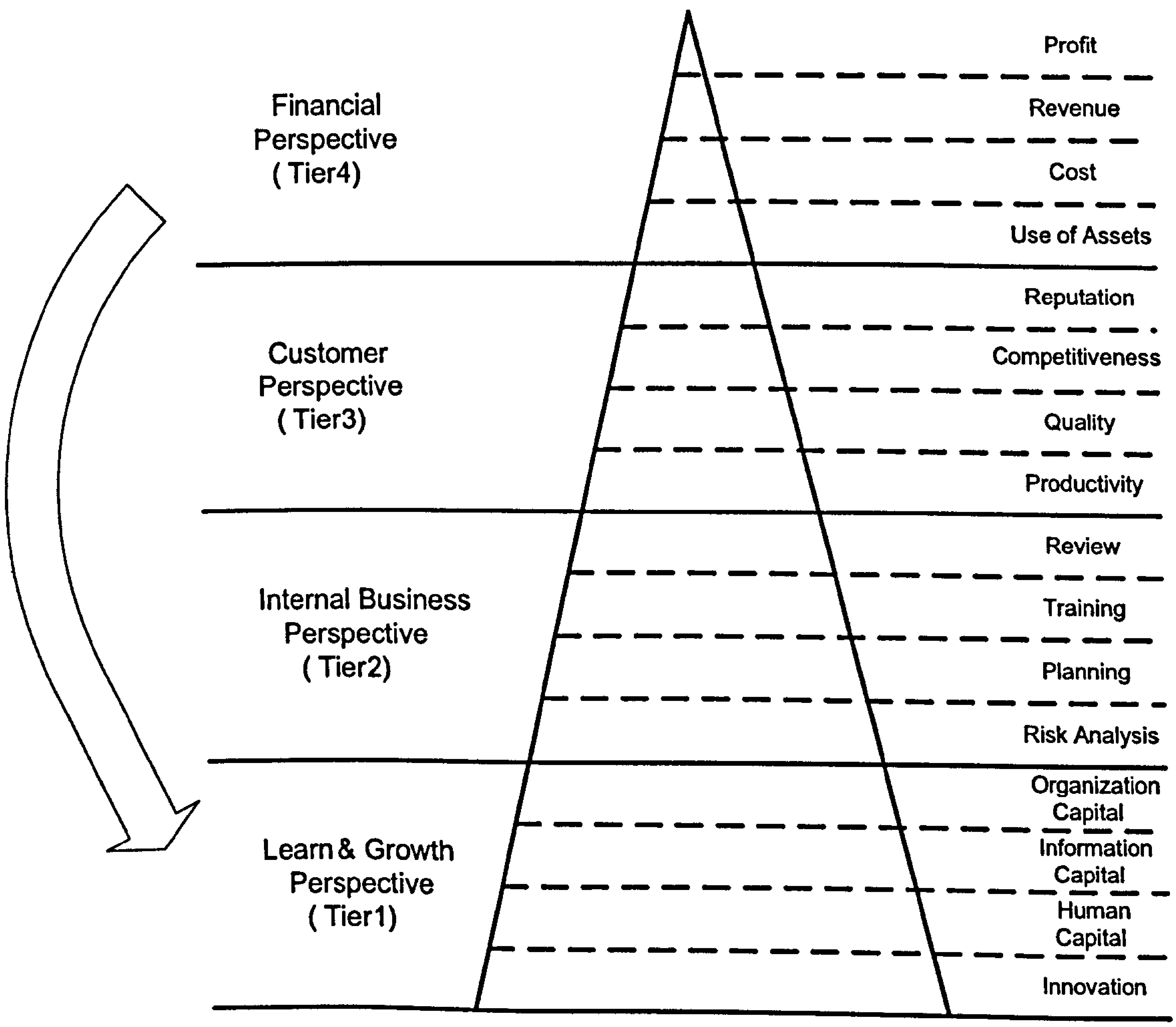

Figure 4.9. The Link of the Proposed Perspectives and their Measures

4.5 Develop BSCs for the Shipping Industry

The proposed measures used in this research are obtained by taking into account the fact that the stakeholders in the shipping industry are a variety of non profit organizations, private companies and groups of people. The literature review is used to address the measures of each representative stakeholder according to its unique needs and obligations. Learn & growth perspective measures are common to all stakeholders since they reflect principles of a successful management. However, the financial perspective measures address the main sources of income and expenses of each stakeholder, which may vary. The customer perspective measures are developed on the basis of the stakeholder analysis in order to identify the regulatory link among the stakeholders. The stakeholders with a high level of authority are considered to be the customers of those stakeholders with a lower authority level. The internal business perspective measures are common to all the stakeholders since they consist of fundamental issues of risk assessment and analysis. The complete BSCs with their measures and perspectives for an evaluation of the shipping industry's regulation implementation performance are shown in Table 4.13.

Table 4.13. The Complete BSCs for an Evaluation of the Shipping Industry's Regulation Implementation Performance

Flag State	
Perspective	**Measure**
Financial	Increase revenues from new registered ships.
	Increase revenues from existing registered fleet.
	Keep administration costs to low level.
	Minimize the need for immediate cash expenditure to meet regulations requirements.
Customer	Increase the operation efficiency of its fleet.
	Create more competitive fleet.
	Increase the quality standards of its fleet.
	Improve fleet records.
Learning and Growth	Reduce the need to hire additionally employees.
	Reduce the need to purchase additionally IT applications.
	Reduce number of its fleet incidents.
	Introduce new ship standards.
Internal Business	Minimize efforts to carry out risk assessment for a regulation.
	Minimize efforts to develop plans to implement a regulation.
	Minimize efforts to provide training regarding implementation of a regulation.
	Minimize efforts to review the internal business process.
Coastal State	
Perspective	**Measure**
Financial	Increase revenues from new port facilities.
	Increase revenue from commercial ports.
	Minimize costs of facilities, administration and services.
	Minimize the need for immediate cash expenditure to meet regulations requirements.

Customer	Increase productivity of ports.
	Increase ports competitiveness.
	Increase the quality standards of its ports.
	Improve safety standards regionally.
Learning and Growth	Reduce the need to hire additionally employees.
	Reduce the need to purchase additionally IT applications.
	Reduce damages to natural resources.
	Introduce new port standards.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.
Classification Society	
Financial	Increase revenues from new services.
	Increase revenue from existing ships of its class.
	Minimize costs of facilities, administration and services.
	Minimize the need for immediate cash expenditure to meet regulations requirements.
Customer	Acquire more contracts with ship operators.
	Increase class competitiveness.
	Increase the quality standards of its ports.
	Improve ships accidents records
Learning and Growth	Reduce the need to hire additionally employees.
	Reduce the need to purchase additionally IT applications.
	Reduce number of its fleet incidents.
	Introduce new ship standards.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.
P&I Club	
Perspective	**Measure**
Financial	Increase revenues from new risks insured.
	Reduce amounts paid for claims.
	Reduce administration costs.
	Minimize the need for immediate cash expenditure to meet regulations requirements.
Customer	Acquire more insurance contracts.
	Increase competitiveness.

	Improve the quality of services.
	Improve accidents records.
Learning and Growth	Reduce the need to hire additionally employees.
	Reduce the need to purchase additionally IT applications.
	Reduce number of claims.
	Introduce new ship operation standards.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.
Underwriter	
Perspective	**Measure**
Financial	Increase revenues from new risks insured.
	Reduce amounts paid for claims.
	Reduce administration costs.
	Minimize the need for immediate cash expenditure to meet regulations requirements.
Customer	Acquire more insurance contracts.
	Increase competitiveness.
	Improve the quality of services.
	Improve accidents records.
Learning and Growth	Reduce the need to hire additionally employees.
	Reduce the need to purchase additionally IT applications.
	Reduce number of claims.
	Introduce new ship operation standards.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.
Shipyard	
Perspective	**Measure**
Financial	Increase revenue from new building ships orders.
	Increase revenue from ships mandatory repairs.
	Reduce administration costs.
	Minimize the need for immediate cash expenditure to meet regulations requirements.
Customer	Increase number of building ships and repairs.
	Increase competitiveness.
	Increase quality shipyards standards.

	Improve ships design reliability.
Learning and Growth	Reduce the need to hire additionally employees.
	Reduce the need to purchase additionally IT applications.
	Reduce number of its claims.
	Introduce new ship design standards.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.

Cargo Owner

Perspective	**Measure**
Financial	Increase revenues due faster transport of cargoes.
	Increase revenue from safer transport of cargoes.
	Minimize losses due accidents.
	Minimize the need for immediate cash expenditure to meet regulations requirements.
Customer	Increase market share.
	Increase reputation and credibility.
	Increase quality of cargoes.
	Reduce the number of accidents caused by cargoes.
Learning and Growth	Reduce the need to hire additionally employees.
	Reduce the need to purchase additionally IT applications.
	Reduce number cargo losses.
	Introduce new cargo transport standards.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.

Marine Consultant

Perspective	**Measure**
Financial	Increase revenues by providing new consultancy services.
	Increase revenues from existing consultancy services.
	Minimize administration costs.
	Minimize the need for immediate cash expenditure to meet regulations requirements.
Customer	Increase number of services.
	Increase reputation and credibility.
	Improve the quality of services.
	Reduce number of failures.

Learning and Growth	Reduce the need to hire additionally employees.
	Reduce the need to purchase additionally IT applications.
	Reduce number of its claims.
	Introduce new ship standards.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.
Ship Operator	
Perspective	**Measure**
Financial	Increase income.
	Decrease capital cost.
	Reduce administration costs.
	Minimize the need for immediate cash expenditure to meet regulations requirements.
Customer	Increase contracts with cargo owners.
	Increase reputation and credibility.
	Improve quality of services.
	Reduce number of claims.
Learning and Growth	Reduce the need to hire additionally employees.
	Reduce the need to purchase additionally IT applications.
	Reduce fleet incidents.
	Introduce new ship standards.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.
Crew Members	
Perspective	**Measure**
Financial	Increase income by additional payments.
	Demand for larger number of crew required onboard.
	Reduce time for training.
	Reduce training expenditures.
Customer	Increase ship operators' satisfaction.
	Increase availability of skill full crewmembers.
	Increase quality of crewmembers.
	Increase reputation and credibility.
Learning and	Improve their knowledge.

Growth	Improve their IT skills.
	Reduce accidents from human error.
	Introduce new ship standards & practices.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.

4.6 Develop BSCs for a Ship Operator

Following the cascade approach of the BSC the measures of Level 4 are used to monitor the performance of each division in the same organization. The measures used for the divisions of a ship operator are shown in Table 4.14. A ship operator has limited sources of revenues, which mainly come from the hire days of the ship in operation (Garcia and Rodriguez 1994). The maximization of its profit depends on the reduction of costs such as maintenance, insufficient operation and damages. Therefore, in this research it is suggested that the profit of some divisions should be measured by the cost caused by failure of this division to meet a regulation such as off-hire days and/or penalties from various authorities. In a similar way, it is difficult to define the productivity of some divisions. Thus, it is suggested that the productivity of every division from the regulatory aspect should be measured by the number of failures that cause cost to the stakeholder.

The BSCs are designed based on the fact that each division of a ship operator must contribute to the effective implementation of a maritime regulation. The four perspectives in Table 4.14 are used in order to describe how each division can achieve the implementation. The measures of each division will vary considerably since their functions and targets are very different. The BSC measures are based on the safety management system of the chosen ship operator and the literature review. In this hierarchy, customers are identified as any other stakeholder of the shipping industry with higher regulatory authority or commercial advantage than a ship operator. The literature review was used to address the proposed measures of a ship operator's divisions according to their unique needs and obligations. The designed BSCs are listed in Table 4.15.

Table 4.14. Proposed Generic Measures for the Implementation of a Maritime Regulation by a Ship Operator and their Measurement Quantities

Perspective	Generic Measure	Measurement Quantity
Financial	Profit	Money (off hire days, penalties etc)
	Revenue	Money
	Cost	Money
	Use of Assets	Money
Customer	Productivity	Number of errors that caused cost
	Competitiveness	Number of claims
	Quality	Number of management deficiencies
	Reputation	Number of accidents
Learning & Growth	Human capital	Number of additionally vacancies
	Information capital	Number of new IT applications
	Organizational capital	Number of human errors
	Innovation	Number of new standards and practices
Internal Business	Risk analysis	Money/hours spent
	Planning	Money/hours spent
	Training	Money/hours spent
	Review	Money/hours spent

Table 4.15. Proposed BSCs for the Implementation of a Maritime Regulation by a Ship Operator

Managing Director	
Perspective	**Measures**
Financial	Increase income.
	Decrease capital cost.
	Reduce administration costs.
	Minimize the need for immediate cash to meet regulations requirements.
Customer	Reduce off hire days.
	Increase reputation and credibility.
	Improve quality of ship's activities.
	Reduce number of claims.
Learn & Growth	Reduce the need to hire additionally employees.
	Reduce the need to purchase additionally IT applications.
	Reduce ship's incidents.
	Introduce new ship standards and/or practices.

Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.
Operation Department	
Perspective	**Measures**
Financial	Increase ship's profit from operational efficiency.
	Reduce operational costs.
	Reduce administration costs.
	Minimize the need for immediate cash to meet regulations requirements.
Customer	Increase ship's operational productivity.
	Increase ship's competitiveness from operation aspect.
	Increase operational quality of ship.
	Reduce errors related to ship's operation.
Learn & Growth	Reduce the need to hire additionally employees in the operation department.
	Reduce the need to purchase additionally IT applications.
	Reduce ship incidents.
	Introduce new ship standards and/or practices.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.
Technical Department	
Perspective	**Measures**
Financial	Increase ship's profit from technical efficiency.
	Reduce maintenance costs.
	Reduce administration costs.
	Minimize the need for immediate cash to meet regulations requirements.
Customer	Increase ship's technical performance.
	Increase ship's competitiveness from technical aspect.
	Increase technical efficiency of ship.
	Reduce ship errors from technical aspect.
Learn & Growth	Reduce the need to hire additionally employees in the technical department.
	Reduce the need to purchase additionally IT applications.
	Reduce ship incidents.
	Introduce new ship standards and/or practices.
Internal	Minimize efforts to carry out risk assessment for a new regulation.

Business	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.

ISM Department

Perspective	**Measures**
Financial	Increase profit by the safe operation of the ship.
	Reduce costs related to maintain safety.
	Reduce administration costs.
	Minimize the need for immediate cash to meet regulations requirements.
Customer	Increase ship's performance from safety aspect.
	Increase ship competitiveness from safety aspect.
	Increase ship's safety standards.
	Reduce ship's safety incidents.
Learn & Growth	Reduce the need to hire additionally employees in the ISM department.
	Reduce the need to purchase additionally IT applications.
	Reduce ship incidents.
	Introduce new ship standards and/or practices.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.

Chartering Department

Perspective	**Measures**
Financial	Increase profit from ship hires.
	Increase revenue from ship hires.
	Reduce costs of ship due to inappropriate execution of charter.
	Minimize the need for immediate cash to meet regulations requirements.
Customer	Increase ship's high performance.
	Increase ship's competitiveness from commercial aspect.
	Increase ship's quality standards.
	Reduce ship commercial errors.
Learn & Growth	Reduce the need to hire additionally employees in the chartering department.
	Reduce the need to purchase additionally IT applications.
	Reduce ship incidents.
	Introduce new ship standards and/or practices.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.

	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.

Accounting Department	
Perspective	**Measures**
Financial	Increase overall cash.
	Increase revenues from ships.
	Reduce administration costs.
	Minimize the need for immediate cash to meet regulations requirements.
Customer	Improve company's wealth.
	Reduce ship's expenses.
	Increase ships quality standards ship from economic aspect.
	Decrease company's financial disorders.
Learn & Growth	Reduce the need to hire additionally employees in the accounting department.
	Reduce the need to purchase additionally IT applications.
	Reduce ship incidents.
	Introduce new ship standards and/or practices.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.

Crew Department	
Perspective	**Measures**
Financial	Increase profit by hiring high quality crew.
	Increase revenue by effective crew performance.
	Reduce crew costs.
	Minimize the need for immediate cash to meet regulations requirements.
Customer	Increase crew efficiency.
	Increase ship's competitive from crew aspect.
	Increase the quality of crew.
	Reduce errors from crew.
Learn & Growth	Reduce the need to hire additionally employees in the Crew Dept.
	Reduce the need to purchase additionally IT applications.
	Reduce ship incidents.
	Introduce new ship standards and/or practices.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.

	Minimize efforts to review the internal business process.
ISPS Department	
Perspective	**Measures**
Financial	Increase profit by the secure operation of the ship.
	Reduce costs related to security.
	Reduce administration costs.
	Minimize the need for immediate cash to meet regulations requirements.
Customer	Increase ship's performance from security aspect.
	Increase ship's competitiveness from security aspect.
	Increase ship's security standards.
	Reduce ship's security incidents.
Learn & Growth	Reduce the need to hire additionally employees in the ISPS Dept.
	Reduce the need to purchase additionally IT applications.
	Reduce ship incidents.
	Introduce new ship standards and/or practices.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.
Supply Department	
Perspective	**Measures**
Financial	Reduce spare parts requisitions.
	Increase revenue by the good operation of the ship.
	Reduce administration costs.
	Minimize the need for immediate cash to meet regulations requirements.
Customer	Increase ship's spares efficiency.
	Increase ship's competitiveness from supply aspect.
	Increase supply quality of ship.
	Reduce ship errors from supply aspect.
Learn & Growth	Reduce the need to hire additionally employees in the Supply Dept.
	Reduce the need to purchase additionally IT applications.
	Reduce ship incidents.
	Introduce new ship standards and/or practices.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.

Ship	
Perspective	**Measures**
Financial	Increase ship income.
	Reduce ship costs.
	Reduce ship administration costs.
	Minimize the need for immediate cash to meet regulations requirements.
Customer	Increase ship's productivity.
	Increase ship's competitiveness.
	Increase ship standards.
	Reduce human errors onboard.
Learn & Growth	Reduce the need to hire additionally crew.
	Reduce the need to purchase additionally IT applications.
	Reduce ship incidents.
	Introduce new ship standards and/or practices.
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.
	Minimize efforts to develop plans to implement a new regulation.
	Minimize efforts to provide training regarding implementation of a new regulation.
	Minimize efforts to review the internal business process.

4.7 Conclusions

The proposed methodology was designed by considering the necessity of stakeholders to adopt a common acceptable tool capable of evaluating the costs and benefits of a new regulation that is introduced in the industry. Among these stakeholders, two have been identified for their importance as the IMO and a ship operator. The choice of these two stakeholders is twofold, first to indicate how the IMO should assess the industry's ability to implement a regulation and secondly to assist a small ship operator to plot its strategy in order to comply effectively with a regulation.

The proposed scorecards for the shipping industry have been designed on the assumption that they will be used by the IMO in order to estimate the performance of a maritime regulation. According to this point of view every stakeholder was considered as a partner of the IMO in the implementation process. The BSCs are also based on the need to focus on a small company's ability to cope with any new regulation. Newly introduced maritime regulations should be understandable and relatively easily executable by every stakeholder.

It should be noted that the complexity of shipping industry can cause some malfunctions to the methodology. Firstly, this methodology, due to various changes in industry, should be periodically reviewed. Secondly, in the case of states, which are large flag administrations and depend on sea trade in their ports such as USA, Japan etc, the tool should be used with care. In this case, it is suggested that two BSCs should be constructed, one as a coastal state and one as a flag state. Then comparisons should take place between the two BSCs in order to find out which state side will prevail. However, many of these countries have clarified their attitude with their actions. For instance, USA is better known in the shipping industry as a coastal state than a flag state.

When implementing the above tools in a ship operator's company it should be considered that one person may be responsible for more than one department of a company. It is essential to ensure that the measures will not confuse each other. Furthermore, the most important issue is the commitment from the highest managerial level for the effective implementation of the tool. The tool will be useless in case where the ship operator is unwilling to comply.

Chapter 5. Implementation of the Proposed Methodology in the Shipping Industry and its Stakeholders

5.1 Introduction

In this chapter, the proposed methodology described in Chapter 4 is presented through two case studies in order to show its applicability. The first case study is used to show how the methodology can be used to evaluate the performance of a regulation in the shipping industry. The second case study is carried out to show the applicability of the methodology to a stakeholder. Eventually a validation is carried out to test the rationality of the methodology and its ability to detect sensitive changes of input.

5.2 Implementation of the Proposed Methodology in the Shipping Industry

In this section, a case study is carried out in order to demonstrate the applicability of the proposed methodology in the shipping industry as a tool for the IMO. The following four steps demonstrate the process that follows:

Step 1: Evaluation of the industry's stakeholders weights.
Step 2: Evaluation of each stakeholders' perspectives weights.
Step 3: Design a tool for the evaluation of industry's implementation performance (industrial tool).
Step 4: Use the industrial tool to evaluate a regulation.

In this case study, the maritime regulation that is chosen to be investigated for its implication to the shipping industry is the "Antifouling Convention" requirements introduced by the IMO. To avoid numerous calculations, the methodology is demonstrated in a small scale. Hence, three representative stakeholders are selected: the flag state, the coastal state and the classification society. Three experts are involved in this study. The ratings in the BSCs are developed on the basis of the previous studies and analyses (Champ 2000), (Champ 2003), (Chambers 2006), (MCA 2007), (ABS 2007).

5.2.1 Evaluation of the Linguistic Terms

After the selection of the experts, the next step is to determine the fuzzy memberships of the linguistic terms, as it was described in Section 4.3.1.4. By following the Delphi method, each expert is required to state the boundaries and the most possible value of the nine proposed linguistic terms in a scale from 1 to 10. These values from every expert represent a fuzzy triangular number for each linguistic term. At the last round of the Delphi method, it is expected that some degree of disagreement among the experts will exist. Therefore, the average value of all experts' opinions is used in order to determine the fuzzy number for each linguistic term, and their results are shown in Figure 5.1. For instance, the linguistic term "strong importance" can be obtained by using Equation 10, as follows:

$$E_{\tilde{M}_t} = \frac{\sum_{i=1}^{r} E_i}{r} = \frac{(4,5,6)+(3,5,6)+(5,6,7)}{3} = (4,5,6)$$

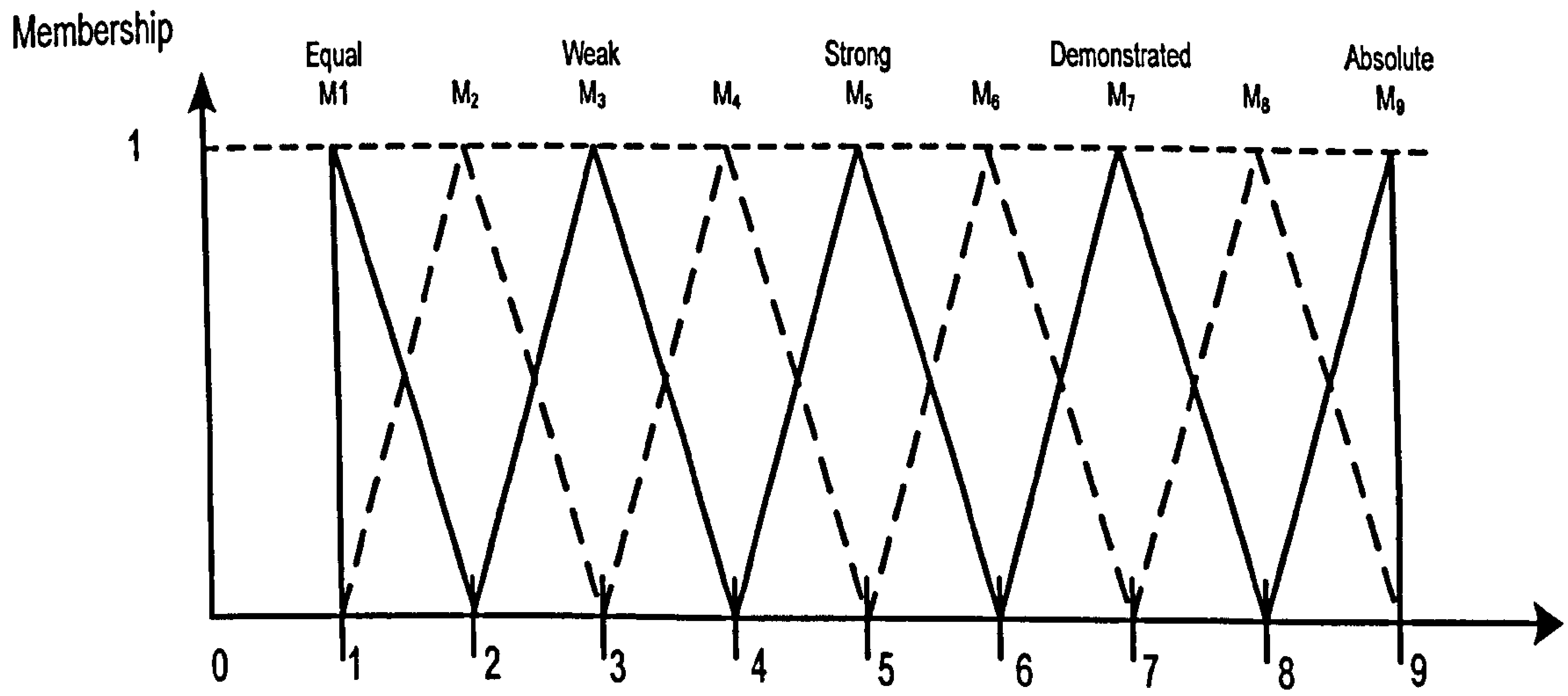

Figure 5.1 The Membership of Linguistic Terms

5.2.2 Evaluation of the Industry's Stakeholders

A hierarchy is designed as shown in Figure 5.2 in order to present this case study. The fuzzy numbers of Figure 5.1 are used to fill in the pairwise comparison matrix for the three chosen stakeholders as shown in Table 5.1. The fuzzy numbers from Table 5.1 are averaged with Equations 6 and 7 and their results are presented in Table 5.2. To demonstrate an example the experts' judgements for the pairwise comparison between flag state and coastal state by reference to Table 5.1 are averaged as below (Equations 6 and 7):

$$\left.\begin{array}{l}(1+1+2)/3=1.33\\(2+2+3)/3=2.33\\(3+3+4)/3=3.33\end{array}\right\}=(1.33,2.33,3.33)$$

For the stakeholders' fuzzy matrix, as shown in Table 5.1, λ_{max} is calculated to be 3.07 by using Equation 5. The RI value is 0.58 by reference to Table 4.1. Therefore, the *CR* and *CI* values for the n=3 matrix are calculated from Equations 3 and 4 as follows:

$$CI=\frac{\lambda_{\max}-n}{n-1}=\frac{3.07-3}{3-1}=0.035$$

$$CR=\frac{CI}{RI}=\frac{0.035}{0.58}=0.06$$

Consequently the judgements for the fuzzy matrix of the stakeholders are consistent since $CR \leq 0.1$.

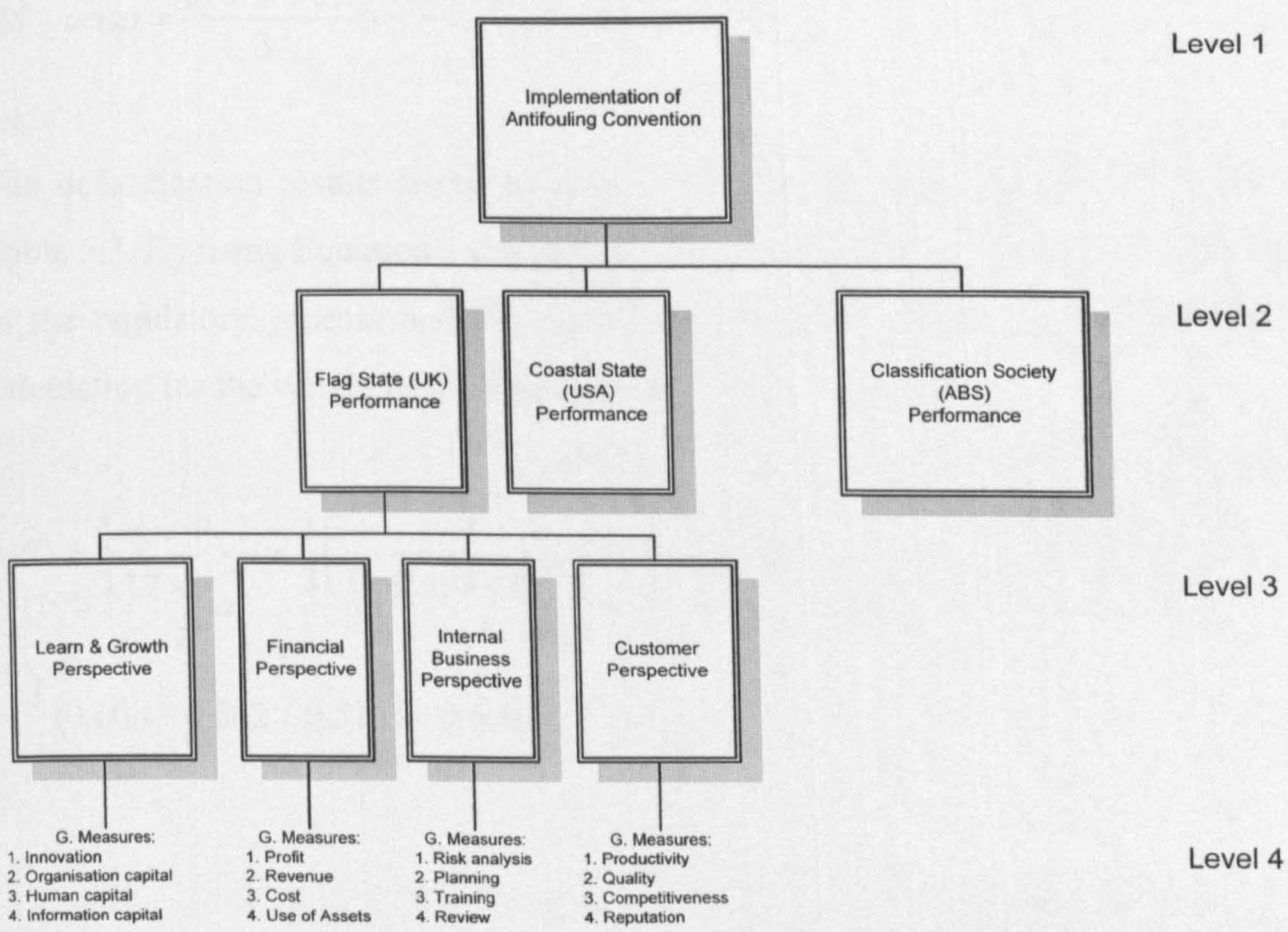

Figure 5.2. The Hierarchical Diagram for Evaluating the Implementation Performance of the Antifouling Convention

Table 5.1. Pairwise Comparisons of the Stakeholders

Stakeholder	Flag State (S^1)	Coastal State (S^2)	Classification Society (S^3)
Flag State (S^1)	(1,1,1)	(1,2,3) (1,2,3) (2,3,4)	(5,6,7) (6,7,8) (6,7,8)
Coastal State (S^2)	wS^2/wS^1	(1,1,1)	(5,6,7) (4,5,6) (4,5,6)
Classification society (S^3)	wS^3/wS^1	wS^3/wS^2	(1,1,1)

Table 5.2. Fuzzy Matrix of the Stakeholders

	Flag State	Coastal State	Classification society
Flag State	(1,1,1)	(1.33,2.33,3.33)	(5.66,6.66,7.66)
Coastal State	(0.30,0.42,0,75)	(1,1,1)	(4.33,5.33,6.33)
Classification society	(0.13,0.15,0.17)	(0.15,0.18,0.23)	(1,1,1)

The fuzzy numbers of the fuzzy matrix for the stakeholders are defuzzified by using Equation 9 as for the pairwise comparison of flag state with coastal state below:

$$M\_crisp = \frac{(b+a+c)}{3} = \frac{1.33+2.33+3.33}{3} = 2.333$$

The defuzzication results from the fuzzy matrix of the stakeholders are shown in Table 5.3. By using Equation 2 the stakeholders are ranked in terms of their weighting in the regulatory process and the results are shown in Table 5.4. An example of calculation for the weight of the flag state wS^1 is shown below:

$$wS^1 = \frac{1}{3}\sum_{j=1}^{3}\frac{a_{ij}}{\sum_{k=1}^{3} a_{kj}} = \frac{1}{3}\left(\frac{1}{1+0.493+0.152} + \frac{2.333}{2.333+1+0.190} + \frac{6.667}{6.667+5.333+1}\right) =$$

$$= \frac{1}{3}(0.608+0.662+0.512) = 0.594$$

Table 5.3. Defuzzication Results for the Fuzzy Matrix of the Stakeholders

	Flag State	**Coastal State**	**Classification society**
Flag State	1.000	2.333	6.667
Coastal State	0.493	1.000	5.333
Classification Society	0.152	0.190	1.000

Table 5.4 shows the relevant weight of each stakeholder, which indicates their relative importance in the implementation process, according to the experts. Therefore, the most important stakeholder in the regulatory process is the flag state followed by the coastal state and finally the classification society. These results verify the stakeholder's analysis from Figure 4.5 where both the flag and coastal states are more important than the classification societies in the regulatory implementation process. However, the flag state's weight is higher than the coastal state, which indicates that the flag state is more important in the regulatory process.

Table 5.4. The Weighting of Stakeholders

Stakeholder	**Weight**	**Rank**
Flag State	0.594	1
Coastal state	0.331	2
Classification society	0.074	3

The experts are requested to make pairwise comparisons for the perspectives of each stakeholder. A detailed example of pairwise comparisons among the perspectives for the flag state stakeholder is carried out and the comparisons are shown in Table 5.5. Then a fuzzy matrix is designed as shown in Table 5.6. The defuzzication results of the fuzzy matrix are shown in Table 5.7. The λ_{max} value of the perspectives fuzzy matrix is calculated to be 4.166 and the *RI* value is 0.9 by reference to Table 4.1. Hence, the *CI* and *CR* values are calculated from Equations 3 and 4 for the n=4 matrix. The consistency of the judgements for the pairwise comparisons of hierarchy Level 3 for the flag state perspectives is acceptable since *CR* is 0.062, which is less than 0.1. The ranking of the flag state perspectives for their burden in the regulatory process is shown in Table 5.8. The procedure described regarding the flag state perspectives ranking is followed for the other two stakeholders. Then the overall priority is calculated according to the procedure in Section 4.2 and the results are shown in Table 5.9.

From Table 5.9 a main conclusion that can be obtained is that according to the experts the perspective with the highest weight for the stakeholders to implement a regulation is generally the financial perspective, followed by the customer perspective, internal business and the learn & growth. Consequently, the stakeholders are more concerned that an introduction of a new regulation can have a severe impact on their economic responsibilities rather than the difficulties to comply with the regulation. It should be stressed that the stakeholders individually may have different priorities. For instance, in the case of the classification society, the customer perspective has higher weight than the financial perspective.

Table 5.5. Pairwise Comparisons for Flag State's Perspectives

Perspective $(P^1_{a,1})$	**Financial** $(P^1_{1,1})$	**Customer** $(P^1_{2,1})$	**Internal Business** $(P^1_{3,1})$	**Learn & Growth** $(P^1_{4,1})$
Financial $(P^1_{1,1})$	(1,1,1)	(1,2,3) (2,3,4) (2,3,4)	(2,3,4) (3,4,5) (3,4,5)	(3,4,5) (5,6,7) (4,5,6)
Customer $(P^1_{2,1})$	$wP^1_{2,1}/wP^1_{1,1}$	(1,1,1)	(2,3,4) (1,2,3) (1,2,3)	(3,4,5) (2,3,4) (2,3,4)
Internal Business $(P^1_{3,1})$	$wP^1_{3,1}/wP^1_{1,1}$	$wP^1_{3,1}/wP^1_{2,1}$	(1,1,1)	(1,2,3) (1,2,3) (1,2,3)
Learn & Growth $(P^1_{4,1})$	$wP^1_{4,1}/wP^1_{1,1}$	$wP^1_{4,1}/wP^1_{2,1}$	$wP^1_{4,1}/wP^1_{3,1}$	(1,1,1)

Table 5.6. Fuzzy Matrix for Flag State's Perspectives

	Financial	Customer	Internal Business	Learn & Growth
Financial	(1,1,1)	(1.66,2.66,3.66)	(2.66,3.66,4.66)	(4,5,6)
Customer	(0.27,0.37, 0.6)	(1,1,1)	(1.33,2.33,3.33)	(2.33,3.33,4.33)
Internal Business	(0.21,0.27,0.37)	(0.3,0.42,0.75)	(1,1,1)	(1,2,3)
Learn & Growth	(0.16,0.2,0.25)	(0.23,0.3,0.42)	(0.33,0.5,1)	(1,1,1)

Table 5.7. Defuzzication Results of Fuzzy Matrix for Flag State's Perspectives

	Financial	Customer	Internal Business	Learn & Growth
Financial	1.000	2.667	3.667	5.000
Customer	0.416	1.000	2.333	3.333
Internal Business	0.287	0.461	1.000	2.000
Learn & Growth	0.206	0.310	0.611	1.000

Table 5.8. The Weight of Flag States Perspectives in the Implementation Regulatory Process

Flag State	Weight	Rank
Financial	0.512	1
Customer	0.261	2
Internal Business	0.141	3
Learn & Growth	0.087	4

Table 5.9. Overall Priority of Stakeholders and Their Perspectives

	Flag State	Coastal State	Classification Society	Overall priority	Overall Rank
Financial	0.512	0.324	0.311	0.497	1
Customer	0.261	0.301	0.317	0.278	2
Internal Business	0.141	0.253	0.272	0.187	3
Learn & Growth	0.087	0.123	0.107	0.100	4

5.2.3 Design a Tool for the Evaluation of the Industry's Performance

The industrial tool is designed by using the BSCs of each stakeholder as they appear in Table 4.13. Each BSC of a stakeholder is filled in with values from 0 to 10 for each measure by reference to Table 4.5. An example of a BSC is shown in Table 5.10, which is the BSC of the UK flag state completed for the antifouling convention.

5.2.4 Evaluation of a Regulation

Each perspective rate of the UK flag state BSC is calculated by multiplying its weight with the average rate of its measures (Equation 11). This is shown for the financial perspective RP_1^1 of the UK flag state below:

$$RP_1^1 = \frac{1}{4}\sum_{g'=1}^{4} Rm_{b',1}^1 \times wP_1^1 = \frac{1}{4}\left(Rm_{1',1}^1 + Rm_{2',1}^1 + Rm_{3',1}^1 + Rm_{4',1}^1\right)\times 0.512 = \frac{1}{4}\left(1+1+2+4\right)\times 0.512 =$$
$$= 2\times 0.512 = 1.024$$

In a similarly way the rates of the other perspectives rates of the UK flag state are calculated as RP_2^1 =1.240, RP_3^1 =0.527 and RP_4^1 =0.497. Then the UK flag state performance pS^l is calculated by aggregating all the perspective values as follows (Equation 12):

$$pS^1 = \sum_{a=1}^{4} RP_a^1 = P_1^1 + RP_2^1 + RP_3^1 + RP_4^1 = 1.024 + 1.240 + 0.527 + 0.497 = 3.288$$

By using Equations 11 and 12 all the stakeholders' performances are computed and their results are shown in Table 5.11. Each stakeholder performance is normalized with its weight wS^c (Equation 13) as below:

$$RS^1 = pS^1 \times wS^1 = 3.288 \times 0.594 = 1.954$$

Finally, all the stakeholders' rates are summed to find the total rate TR (Equation 14):

$$TR = \sum_{c=1}^{u} RS^c = RS^1 + RS^2 + RS^3 = 1.954 + 1.326 + 0.436 = 3.717$$

In Table 5.11, the measures with rates of less than five indicate where the UK flag state faced difficulties during the implementation of the antifouling convention requirements. The value five out of ten is chosen because it represents 50% of the desired goal. A perspective rate is dependable from its weight and the rates of its measures. For instance, the performance of the UK flag state has a low value because its perspectives with the higher weights have measures with small values. More precisely, the values of the financial and customer perspectives rates of the UK flag state, which have the higher weights, were computed to be 1.024 and 1.240 respectively, although their measures have low values. In contrast, the internal business perspective with average measure rates equal to 5.75 increased the UK flag state performance only by 0.497 due to its small weight. It should be stressed that other flag states with less knowledge and resources may achieve much lower rates. This is an indication that the antifouling convention may cause significant implementation difficulties to flag states from developing states.

As can be seen from Table 5.11 the perspective rates for the three chosen stakeholders lie between 3 and 6. These values are in the range of low and medium performance (Table 4.5). This is an indication that the stakeholders faced many challenges during the implementation of the antifouling convention. For instance, the average of financial measures for the UK flag state is 2 and for the US coastal state is 3. Consequently, the summation of low stakeholders' rates is giving a total rate equal to 3.717, which is low performance by reference to experts' judgements (Table 4.5). However, if the total rate is calculated without taking into account the weights of each stakeholder and its perspectives then the total rate would be equal to 4.604, which is higher than 3.717 and would lead to the conclusion that the industry has medium performance.

The antifouling issue has been studied since 1980 by many states and researchers (Champ 2000). The costs through banning TBT paints from the industry are also well known to states and scientists. The proposed methodology is providing an explanation of why states have a very slow reaction although the public is exposed to healthy risk. In addition, it gives evidence of the limitations in implementation of the antifouling convention since the states that have not rectified the convention are in great economic advantage.

Table 5.10. Implementation Performance of the UK Flag State

P_a^c	$m_{b^a,c}^a$	$Rm_{b^a,c}^a$	$\frac{1}{4}\sum_{b^a=1}^{g^a} Rm_{b^a,c}^a$	wP_a^c	RP_a^c	pS^c
Financial	Increase revenues from new registered ships.	1	2	0.512	1.024	3.288
	Increase revenues from existing registered fleet.	1				
	Keep administration costs to low level.	2				
	Minimize the need for immediate cash expenditure to meet regulations requirements.	4				
Customer	Increase the operation efficiency of its fleet.	2	4.75	0.261	1.240	
	Create more competitive fleet.	7				
	Increase the quality standards of its fleet.	3				
	Improve fleet records.	7				
Internal Business	Reduce the need to hire additionally employees.	3	3.75	0.141	0.527	
	Reduce the need to purchase additionally IT applications.	4				
	Reduce number of its fleet incidents.	4				
	Introduce new ship standards.	4				
Learn & Growth	Minimize efforts to carry out risk assessment for a regulation.	5	5.75	0.087	0.497	
	Minimize efforts to develop plans to implement a regulation.	5				
	Minimize efforts to provide training regarding implementation of a regulation.	5				
	Minimize efforts to review the internal business process.	8				

Table 5.11. The Implementation Performance of the Industry

S^c	P_a^c	$\frac{1}{4}\sum_{b^a=1}^{g^a} Rm^a_{b^a,c}$	RP_a^c	pS^c	wS^c	RS^c	TR
Flag State	Financial	2	1.024	3.288	0.594	1.954	3.717
	Customer	4.75	1.240				
	Learn & Growth	3.75	0.527				
	Internal Business	5.75	0.497				
Coastal State	Financial	3	0.971	4.005	0.331	1.326	
	Customer	5	1.505				
	Learn & Growth	3.5	0.885				
	Internal Business	5.25	0.644				
Classification Society	Financial	6.25	1.944	5.855	0.074	0.436	
	Customer	5.75	1.785				
	Learn & Growth	6.25	1.700				
	Internal Business	4	0.426				

5.2.5 Review

The proposed BSCs can be used as a monitoring tool of the implementation performance of the shipping industry or a stakeholder. Due to the hierarchical analysis of the regulation implementation process the proposed methodology provides a detailed analysis for the industry and its stakeholders. Periodical reassessment of a regulation can contribute to identify the progress of the regulation's implementation in the industry. By adopting this approach, the results of the tool may be used as a benchmark. In addition, stakeholders can improve their compliance and business practices by targeting the highest performance rate, *TR*.

The proposed tool can contribute to a more effective implementation of regulation by revaluating of the stakeholders' performance in time intervals. Therefore, the initial evaluation total rate should be used as a benchmark for following evaluations. The target is to continuously improve the total rate. For instance, in this case study the stakeholders achieved a total rate equal to 3.717, which is an indication of low performance (Table 4.5). Since the regulation is already in the implementation process, the stakeholders must achieve the targets of the regulations in a short period. An increase of the total rate in later evaluations will be a good indication of the overall progress of the industry. However, there is a possibility that the total rate may reach a point, which cannot be exceeded. In this case, it may be an indication that some requirements of the regulation are too challenging to be met by the industry and it may be necessary to revise these requirements.

The proposed industrial tool was designed in order to list and evaluate the benefits and costs, in a broad sense, that a regulation will produce to the shipping industry. Thus by reading the rates of the tool it may be possible to indicate where each stakeholder failed. A possible solution will be to improve his strategy by improving his management structure, or investing in resources. In this case study under the learn & growth perspective of the UK flag state there is the measure "Minimize efforts to carry out risk assessment for a regulation" which is rated 4. This measure needs improvement and therefore an effective risk assessment at the early stages of the regulation's implementation will improve the rate. However, a careless risk assessment may cause periodical reassessment of the regulation and produce decrease in the rate of the measure. An ineffective initial assessment may generate grounds for near misses deficiencies, or accidents that will probably be discovered by a ship inspector such as a port state control officer. A reduction of the measure's rate may indicate that the initial assessment was carelessly prepared.

The above case study demonstrated that the proposed methodology could be used to deal with the regulation implementation issue by breaking a regulation into small parts in the context of a multi structure problem. Methods that have been used in the past in other industries were combined to produce the proposed methodology. The designed methodology is capable of calculating and measuring the implementation performance of a stakeholder for a given regulation. When all the stakeholders succeed a high performance then the regulation will have been successfully implemented.

5.3 Implementation of the Proposed Methodology in a Stakeholder's Organisation

In this section, the proposed methodology is extended to demonstrate its applicability on evaluating a stakeholder's organisation regulatory performance by the means of a case study. As it was explained in Section 4.3.2.5 this is an extension of the first case study. Thus, the values of the linguist terms of Figure 5.1 are used. The following three steps demonstrate the calculation process of the generic framework:

Step 1: Evaluate the ship operator's divisions weights.
Step 2: Evaluate each division's perspectives weights.
Step 3: Design a tool for the evaluation of a stakeholder's implementation performance (stakeholder tool).

In this case study, the maritime regulation that is chosen to be investigated for its implication to the ship operator is the double skin requirements for bulk carriers introduced by the IMO. To avoid numerous calculations, the methodology is demonstrated in a small scale. Hence, three divisions are selected: the operation department, the technical department and the ISM department. Additionally the number of experts chosen is three. The ratings in the BSCs are developed on the basis of the previous studies and analyses (IMO 2000), (IMO 2004a, b).

5.3.1 Evaluation of the Ship Operator's Divisions

A hierarchy is designed as shown in Figure 5.3 in order to present graphically the evaluation of the regulation's implementation performance by a ship operator. A pairwise comparison matrix is completed for the three chosen divisions as it is shown in Table 5.12. The fuzzy numbers from Table 5.12 are added and averaged with Equations 6 and 7 and their results are presented in Table 5.13. For the fuzzy numbers a defuzzication process follows to obtain crisp numbers (*M_crisp*) by using Equation 9.

All the defuzzication results from the fuzzy matrix of the divisions are shown in Table 5.14. By using Equation 2 the divisions are ranked in terms of their weights in the regulatory process and the results are shown in Table 5.15. For the divisions' matrix, as shown in Table 9, λ_{max} is calculated to be 3.1 by using Equation 5. The *RI* value is 0.58 by reference to Table 4.1. Therefore, the *CR* and *CI* values for the n=3 matrix are calculated from Equations 3 and 4 to be 0.05 and 0.086 respectively. Consequently, there is a consistency for the fuzzy matrix of the divisions since $CR \leq 0.1$.

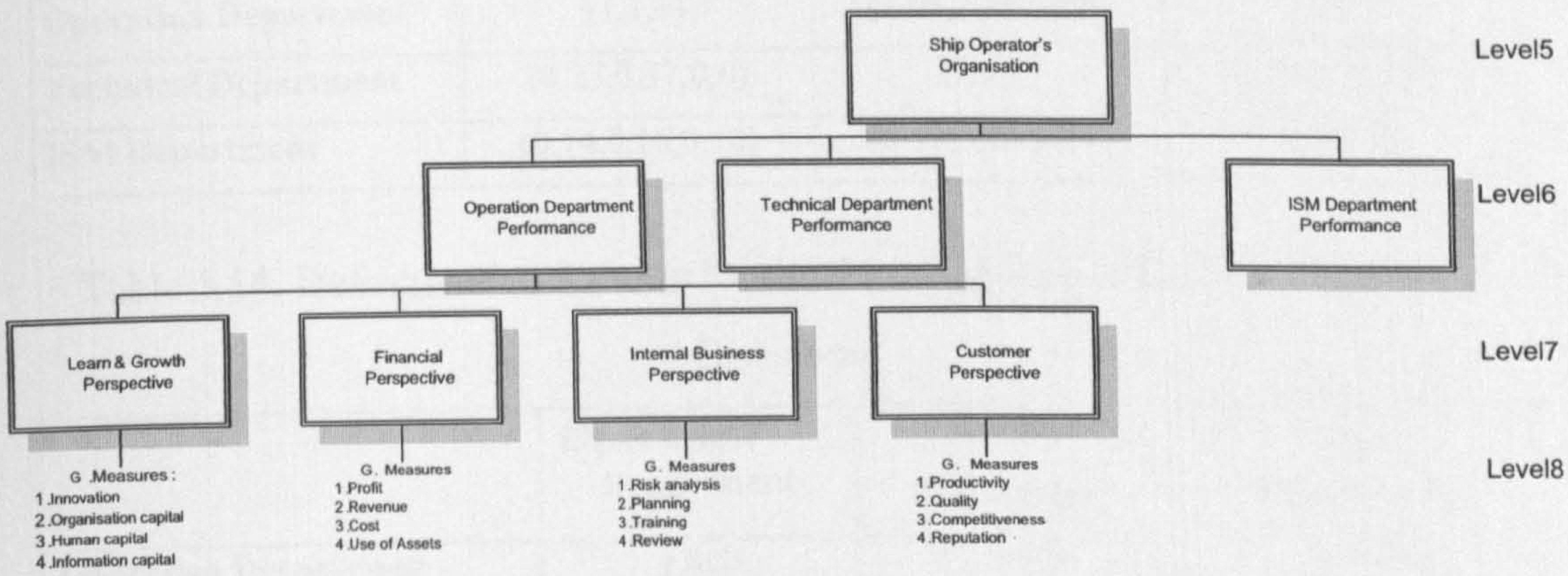

Figure 5.3. The Hierarchical Diagram for Evaluating the Implementation Performance of Double Skin

In Table 5.15, the ranking order of the divisions it is displayed in terms of their importance in the regulatory implementation process of a Ship Operator. It appears that the most important division in the regulatory process is the operation department followed by the technical department and the ISM department.

Table 5.12. Pairwise Comparisons of the Ship Operator's Divisions

	Operation Department (D_1^5)	**Technical Department (D_2^5)**	**ISM Department (D_3^5)**
Operation Department (D_1^5)	(1,1,1)	(1,2,3) (2,3,4) (2,3,4)	(5,6,7) (4,5,6) (6,7,8)
Technical Department (D_2^5)	wD_2^5/wD_1^5	(1,1,1)	(3,4,5) (4,5,6) (4,5,6)
ISM Department (D_3^5)	wD_3^5/wD_1^5	wD_3^5/wD_2^5	(1,1,1)

Table 5.13. Fuzzy Matrix of the Ship Operator's Divisions

	Operation Department	Technical Department	ISM Department
Operation Department	(1,1,1)	(1.66,2.66,3.66)	(5,6,7)
Technical Department	(0.27,0.37,0,6)	(1,1,1)	(3.66,4.66,5.66)
ISM Department	(0.14,0.16,0.10)	(0.17,0.21,0.27)	(1,1,1)

Table 5.14. Defuzzication Results for the Fuzzy Matrix of the Ship Operator's Divisions

	Operation Department	Technical Department	ISM Department
Operation Department	1.000	2.667	6.000
Technical Department	0.416	1.000	4.667
ISM Department	0.170	0.218	1.000

Table 5.15. The Weighting of Divisions

	Weight	Rank
Operation Department	0.610	1
Technical Department	0.307	2
ISM Department	0.083	3

As it is required in the questionnaire, the experts make pairwise comparisons for the perspectives of each division, which are partially displayed in Table 5.16 for the division of the operation department as an example. The pairwise comparisons are used to design a fuzzy matrix as is shown in Table 5.17 for the same division. The defuzzication results of the fuzzy matrix are shown in Table 5.18 and its λ_{max} value is calculated to be 4.267. The *CR* value is calculated to be 0.099 from Equations 3 and 4 for the n=4 matrix and the *RI* value equal to 0.9 by reference to Table 4.1. The consistency of the matrix is acceptable since *CR* is less than 0.2. The ranking of the perspectives for their weights in the regulatory process is shown in Table 5.19. The ranking of the other two divisions and their perspectives is carried out with the same procedure as described for the operation department. The overall priority is then displayed in Table 5.20.

Table 5.16. Pairwise Comparisons for Operation Department's Perspectives

Perspective $(P^5_{a,u})$	Financial $(P^5_{1,1})$	Customer $(P^5_{2,1})$	Internal Business $(P^5_{3,1})$	Learn & Growth $(P^5_{4,1})$
Financial $(P^5_{1,1})$	(1,1,1)	(3,4,5) (2,3,4) (2,3,4)	(4,5,6) (3,4,5) (3,4,5)	(6,7,8) (5,6,7) (5,6,7)
Customer $(P^5_{2,1})$	$wP^5_{2,1}/wP^5_{1,1}$	(1,1,1)	(4,5,6) (3,4,5) (3,4,5)	(4,5,6) (5,6,7) (5,6,7)
Internal Business $(P^5_{3,1})$	$wP^5_{3,1}/wP^5_{1,1}$	$wP^5_{3,1}/wP^5_{2,1}$	(1,1,1)	(2,3,4) (1,2,3) (1,2,3)
Learn & Growth $(P^5_{4,1})$	$wP^5_{4,1}/wP^5_{1,1}$	$wP^5_{4,1}/wP^5_{2,1}$	$wP^5_{4,1}/wP^5_{3,1}$	(1,1,1)

In Table 5.20 it is shown that the perspective with the highest weight for the divisions to implement a regulation is the financial perspective, followed by the customer perspective, internal business and the learn & growth. These results indicate that for a ship operator the cost reduction that can be achieved from each department by the implementation of a new regulation the most significant. On the other hand, the difficulties generated by additional workload to fulfil the regulation's requirements and to improve his organisation functions are of second priority. It is expected that for some divisions their priorities may be different. For instance, in the ISM department the customer perspective is ranked higher than the financial perspective.

Table 5.17 Fuzzy Matrix for Operation Department's Perspectives

	Financial	Customer	Internal Business	Learn & Growth
Financial	(1,1,1)	(2.33,3.33,4.33)	(3.33,4.33,5.33)	(5.33,6.33,7.33)
Customer	(0.23,0.30, 0.42)	(1,1,1)	(3.33,4.33,5.33)	(4.66,5.66,6.66)
Internal Business	(0.18,0.23,0.30)	(0.18,0.23,0.30)	(1,1,1)	(1.33,2.33,3.33)
Learn & Growth	(0.13,0.42,0.75)	(0.15,0.17,0.21)	(0.30,0.43,0.75)	(1,1,1)

Table 5.18. Defuzzication Results of Fuzzy Matrix for the Operation Department's Perspectives

	Financial	Customer	Internal Business	Learn & Growth
Financial	1.000	3.333	4.333	6.333
Customer	0.320	1.000	4.333	5.667
Internal Business	0.239	0.235	1.000	2.333
Learn & Growth	0.161	0.178	0.493	1.000

Table 5.19. The Weight of Operation Department's Perspectives in the Implementation Regulatory Process

Perspective	Weight	Rank
Financial	0.531	1
Customer	0.298	2
Internal Business	0.110	3
Learn & Growth	0.061	4

Table 5.20. Overall Priority of Divisions and their Perspectives

	Operation Department	Technical Department	ISM Department	Overall priority	Overall Rank
Financial	0.531	0.485	0.311	0.513	1
Customer	0.298	0.304	0.317	0.301	2
Internal Business	0.110	0.127	0.272	0.129	3
Learn & Growth	0.061	0.083	0.107	0.072	4

5.3.2 Design a Tool for the Evaluation of the Stakeholder's Performance

The stakeholder tool is designed by using the BSCs of each division as they appear in Table 4.7. Each BSC of a division is filled in with values from 0 to 10 for each measure by reference to Table 4.5. An example of a BSC is shown in Table 5.21, which is the BSC of the operation department completed for bulk carrier double skin requirements.

5.3.3 Evaluation of a Regulation

The rate of each perspective is calculated by multiplying its weight with the average rate of its measures. These values have been assessed in the relevant BSC of the operation department (Equation 16). The financial perspective of the operation department is calculated:

$$RP_{1,1}^{5} = \frac{1}{4}\sum_{g^{1}=1}^{4} Rm_{b^{1},5^{1}}^{1} \times wP_{1,1}^{5} = \frac{1}{4}\left(Rm_{1^{1},5^{1}}^{1} + Rm_{2^{1},5^{1}}^{1} + Rm_{3^{1},5^{1}}^{1} + Rm_{4^{1},5^{1}}^{1}\right) \times 0.531$$

$$= \frac{1}{4}(2+2+2+1) \times 0.531 = 1.75 \times 0.531 = 0.929$$

By carrying out similar calculations as for the financial perspective the rates of the other perspectives of operation department are found to be $RP_{2,1}^{5}$=1.342, $RP_{3,1}^{5}$=0.384 and $RP_{4,1}^{5}$=0.352. Then the operation department performance pD_{1}^{5} is calculated by summing its perspectives values (Equation 17):

$$pD_{1}^{5} = \sum_{a=1}^{l} RP_{a,1}^{5} = RP_{1,2}^{5} + RP_{2,1}^{5} + RP_{3,1}^{5} + RP_{4,1}^{5} = 0.929 + 1.342 + 0.384 + 0.352 = 3.007$$

By using Equations 16 and 17 all the divisions' performances are computed and their results are shown in Table 5.22. Each division's performance is normalized with its weight wD_{u}^{c} (Equation 18). For example, the operational department's performance is calculated as:

$$RD_{1}^{5} = pD_{1}^{5} \times wD_{1}^{5} = 3.007 \times 0.610 = 1.836$$

Finally, all the divisions' rates are summed to find the total rate S_{TR}^{c} (Equation 19):

$$S_{TR}^{5} = \sum_{u=1}^{l} RD_{u}^{5} = RD_{1}^{5} + RD_{2}^{5} + RD_{3}^{5} = 1.836 + 1.077 + 0.411 = 3.323$$

The overall results of the operation department are displayed in Table 5.22. From Table 5.22 it is easy to identify which measures of the operation department have failed to perform well during the implementation of the double skin requirements for bulk carriers. The financial and customer perspectives, which have the higher weights, contributed 0.929 and 1.342 respectively to the division's performance. On the other hand, the learn & growth perspective with an average of measure rates equal to 5.75

increased the performance of the operation department by 0.352. Eventually the internal business perspective's measures had low values therefore contributing only 0.384 to the division's performance.

Table 5.21. Implementation Performance of the Operation Department

$P^c_{a,u}$	$m^a_{b^a,c^u}$	$Rm^a_{b^a,c^u}$	$\frac{1}{4}\sum_{b^u=1}^{g^u} Rm^a_{b^a,c^u}$	$wP^c_{a,u}$	$RP^c_{a,u}$	pD^c_u
Financial	Increase ship's profit from operational efficiency.	2	1.75	0.531	0.929	3.007
	Reduce operational costs.	2				
	Reduce administration costs.	2				
	Minimize the need for immediate cash to meet regulations requirements.	1				
Customer	Increase ship's operational productivity.	4	4.5	0.298	1.342	
	Increase ship's competitiveness from operation aspect.	7				
	Increase operational quality of ship.	3				
	Reduce errors related to ship's operation.	4				
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.	4	3.5	0.110	0.384	
	Minimize efforts to develop plans to implement a new regulation.	3				
	Minimize efforts to provide training regarding implementation of a new regulation.	3				
	Minimize efforts to review the internal business process.	4				
Learn & Growth	Reduce the need to hire additionally employees in the operation department.	5	5.75	0.061	0.352	
	Reduce the need to purchase additionally IT applications.	5				
	Reduce ship incidents.	5				
	Introduce new ship standards and/or practices.	8				

This case study shows a detailed analysis of the factors that may affect the performance of the chosen divisions during the implementation of the double skin requirements. It is easier to improve the regulation by carrying out further studies on how it could less affect a ship operator financially. For instance, a prohibition of operation of the single-skin bulk carriers after certain years may reduce the economic advantage of those ship operators with single-skin bulk carriers. However, such a proposal may be in conflict with the market demand and cause difficulties to charterers, cargo owners and developing states. This may be the reason for so many arguments, mainly from ship operators (IMO 2004a), against such a proposal whose purpose is to make ships safer.

Table 5.22. The Implementation Performance of the Ship Operator

D^c_u	$P^c_{a,u}$	$\frac{1}{4}\sum_{b^c=1}^{g^c} Rm^a_{b^c,c^c}$	$RP^c_{a,u}$	pD^c_u	wD^c_u	RD^c_u	S^c_{TR}
Operation Department	Financial	1.75	0.929	3.007	0.610	1.863	3.323
	Customer	4.5	1.342				
	Learn & Growth	3.5	0.384				
	Internal Business	5.75	0.352				
Technical Department	Financial	3	1.455	3.511	0.307	1.077	
	Customer	3.75	1.142				
	Learn & Growth	3.75	0.476				
	Internal Business	5.25	0.438				
ISM Department	Financial	4	1.244	4.953	0.083	0.411	
	Customer	7.25	2.250				
	Learn & Growth	3.5	0.952				
	Internal Business	4.75	0.506				

5.3.4 Review

It is of high importance for a stakeholder to be able to monitor his implementation performance. The proposed tool may be used to fulfil this need of stakeholders. A periodical reassessment of the regulation can contribute to identify the progress of a regulation's implementation. By making comparisons between time intervals, a stakeholder can improve his performance and business practices by targeting and planning an increase of his score. The review may be carried out in two directions: one overall for the organisation and one individually for each division.

In this case study the ship operator on an initial evaluation achieved a S_{TR}^{5} value equal to 3.2.3, which is an indication of low performance. Since the regulation is already in force, the ship operator is obligated under national and international legislation to achieve the regulation's targets. Therefore, the S_{TR}^{5} can be used as a benchmark, which should rapidly increase. An increase of the value of S_{TR}^{5} will be a good indication of the overall progress of the company. This process is essential in regulation implementation since in the modern shipping world there is not much space for errors and bad management decisions due to their severe consequences.

A ship operator may use the obtained rates from the tool in order to track his organisation failures and successes. Possible solutions to his failures should include improvement of his strategy, reorganisation of his management structure, or investment in new resources. However, it should be noted that in the first attempt of a ship operator to implement a regulation his failure rate may be higher due to an initial careless implementation or lack of resources. Consequently, it is possible that this failure rate will probably affect the other divisions.

5.4 Validation

The proposed methodology is new and results from a combination of other sound methods. Therefore, it is necessary to investigate if the proposed method is sensitive to slight changes of input and if these changes are reflecting to the output. It should be highlighted that the methodology is applicable to two interactive parts, one for the shipping industry and the other for a ship operator. This approach leads into two identical equations which are Equation 15 and Equation 19. Therefore, the same validation method can be used for both of them. In order to avoid repeated calculations Equation 19 is tested in this section, as an example of both Equations, for its sensitivity to the changes of its inputs, which are the measures and the weights.

Equation 19 has three groups of variables which are the weights of divisions and perspectives and the values of the measures. The weight of each perspective or division is the outcome of experts' judgements while the values of the measures depend on the feedbacks of the person who uses the tool. Regarding the perspectives and divisions' weights, many researchers who carried out sensitivity analysis for the AHP method suggest that small changes in weights such as 20% should not cause rank reversal (Chang et al 2007), (Kahraman et al 2007). Therefore, the sensitivity analysis can be carried out by the following tasks:

Task 1: Examine if the ranking order of the divisions and perspectives is changing when an expert changes his judgement.

Task 2: Examine if the ranking order of the divisions and perspectives is changing when the weight of one division or perspectives changes up to 30%.

Task 3: Examine if the S^5_{TR} value increases when measures' values increase.

Task 4: Examine if the S^5_{TR} value increases when a perspective or division rate increases.

To facilitate the above tasks the weights of case study 2 are used as a reference. Since the scope of sensitivity analysis is to test that the proposed equation is sensitive to small changes to one perspective or its measures from the division Operation Department are examined. All measures of the Operation Department's BSC are valued equal to 0 as it is shown in Table 5.23. Hence, the result of any change to a value of a measure or a weight will be easily detected.

Table 5.23. The BSC for the Operation Department with 0 Values

Operation Department									
$Rm^{1}_{1',5'}$	$Rm^{1}_{2',5'}$	$Rm^{1}_{3',5'}$	$Rm^{1}_{4',5'}$	$\frac{1}{4}\sum_{b=1}^{g} Rm^{a}_{b^a,c^a}$	$wP^5_{a,1}$	$RP^5_{a,1}$	pD^5_1	wD^5_1	S^5_{TR}
0	0	0	0	0	0.531	0	0	0.610	0
0	0	0	0	0	0.298	0			
0	0	0	0	0	0.110	0			
0	0	0	0	0	0.061	0			

To examine the validity of Task 1 it is assumed that one expert changes his judgement regarding finance-customer comparison of Operation Department. His initial judgement that the finance perspective is weekly important (M_3) than the customer perspective has changed to strong to demonstrated important (M_6) in favour of finance perspective. Due to this change the weight of finance perspective increases from 0.531 to 0.551 but the ranking order is maintained. Similar calculations are repeated for every pairwise comparison for all the perspectives of the Operation Department and the results are shown in Table 5.24. It is noticed that in every case the ranking order is maintained.

Table 5.24 The Effect of an Expert's Judgement Perturbation to the Perspectives' Weights

Perspectives	Initial Values	Increase of $P^5_{1,1}$ over $P^5_{2,1}$	Increase of $P^5_{1,1}$ over $P^5_{3,1}$	Increase of $P^5_{1,1}$ over $P^5_{3,1}$	Increase of $P^5_{2,1}$ over $P^5_{3,1}$	Increase of $P^5_{2,1}$ over $P^5_{4,1}$	Increase of $P^5_{3,1}$ over $P^5_{4,1}$
$P^5_{1,1}$	0.531	0,551	0,548	0,541	0,523	0,528	0,526
$P^5_{2,1}$	0.298	0,279	0,290	0,294	0,312	0,303	0,294
$P^5_{3,1}$	0.110	0,109	0,102	0,108	0,105	0,109	0,123
$P^5_{4,1}$	0.061	0,061	0,061	0,057	0,060	0,060	0,056

In Task 2, which is an extension of Task 1, the weight of the Operation Departments' financial perspective is increased until to change 30%. This change could be caused if more than one experts change their judgement in favour of the financial perspective. The result of this change is that the ranking order is still the same as it is shown in Table 5.25. The procedure is repeated for the other perspectives and the results are shown in Table 5.25. In all cases the ranking order of the perspectives does not cause rank reversal.

The S^5_{TR} value is independent from the perspectives weights. This can be proved by repeating the calculations from Task 2 while all measures' values are equal to 5. All the calculations produce the same S^5_{TR} value as it is shown in Table 5.25.

To examine Task 3 suppose that for financial perspective the sum of its measures values gradually increases from 1 to 20 while other perspectives measures and weights values are 0. By carrying out the calculations of Equation 19, it is noticed that every increase of a measure's value is causing an increase to the financial perspective rate and to the S^5_{TR}. In a similar way the procedure is followed for every perspective and the results are shown in Table 5.26. As it is shown in Figure 5.4 a change of the values of perspective $P_{1,1}^5$ measures by 20 is increasing the S_{TR}^5 by 1.619. In contrast a change of the values of perspective's $P_{4,1}^5$ measures by 20 is adding only 0.187 points to the S_{TR}^5. Therefore, the S_{TR}^5 value increases more if the perspectives with the higher weight achieve the highest values. Additionally it is shown that the S_{TR}^5 value is sensitive to the perspectives' measures changes.

In Task 4 it should be shown that every time that a perspective rate increases the S_{TR}^5 increases accordingly. As it is shown in Figure 5.4 the increase of a perspective rate depends on its weight. For instance, the rate of perspective $P_{1,1}^5$ for the operation's department is increasing to 2.654 while the perspective $P_{4,1}^5$ rate is reaching to 0.306 for the same sum of measures value. This difference is reasonable since the perspective's $P_{1,1}^5$ weight is 8.7 times higher than the weight of perspective $P_{4,1}^5$. Consequently, each perspective rate contributes to the increase of the S_{TR}^5 value with a different proportion.

Table 5.25. The Effect of Changing the Weight of a Perspective to the Perspectives Ranking and Total Rate

Perspective Weights	Initial Values	Change of $wP_{1,1}^5$ by 30%	Change of $wP_{2,1}^5$ by 30%	Change of $wP_{3,1}^5$ by 30%	Change of $wP_{4,1}^5$ by 30%
$wP_{1,1}^5$	0.531	0.694	0.479	0.521	0.506
$wP_{2,1}^5$	0.298	0.188	0.388	0.285	0.297
$wP_{3,1}^5$	0.110	0.072	0.085	0.142	0.119
$wP_{4,1}^5$	0.061	0.046	0.048	0.051	0.078
S_{TR}^5	3.05	3.05	3.05	3.05	3.05

Table 5.26. Increase of Measure Rates and their Effect to their Parent Perspective and to Total Rate

Operation Department								
Increase of Measures' Rates	$P_{1,1}^{5}$	S_{TR}^{5}	$P_{2,1}^{5}$	S_{TR}^{5}	$P_{3,1}^{5}$	S_{TR}^{5}	$P_{4,1}^{5}$	S_{TR}^{5}
0	0	0	0	0	0	0	0	0
1	0.133	0.081	0.075	0.045	0.027	0.017	0.015	0.009
2	0.265	0.162	0.149	0.091	0.055	0.034	0.031	0.019
3	0.398	0.243	0.224	0.136	0.082	0.05	0.046	0.028
4	0.531	0.324	0.298	0.182	0.11	0.067	0.061	0.037
5	0.664	0.405	0.373	0.227	0.137	0.084	0.076	0.047
10	1.327	0.809	0.745	0.455	0.275	0.168	0.153	0.093
20	2.654	1.619	1.491	0.909	0.549	0.335	0.306	0.187

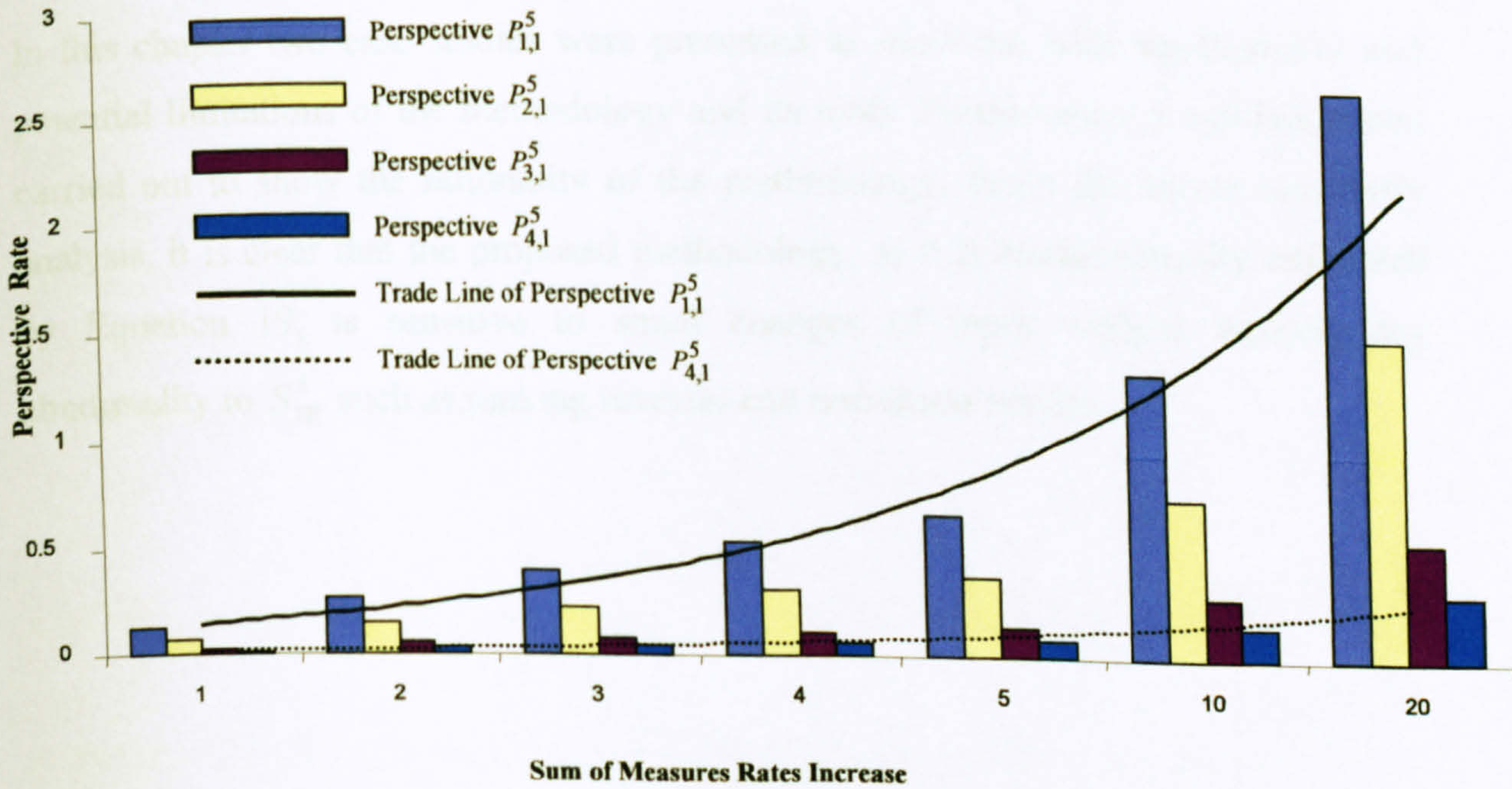

Figure 5.4. The Effect of Measures Increase to their Parent Division

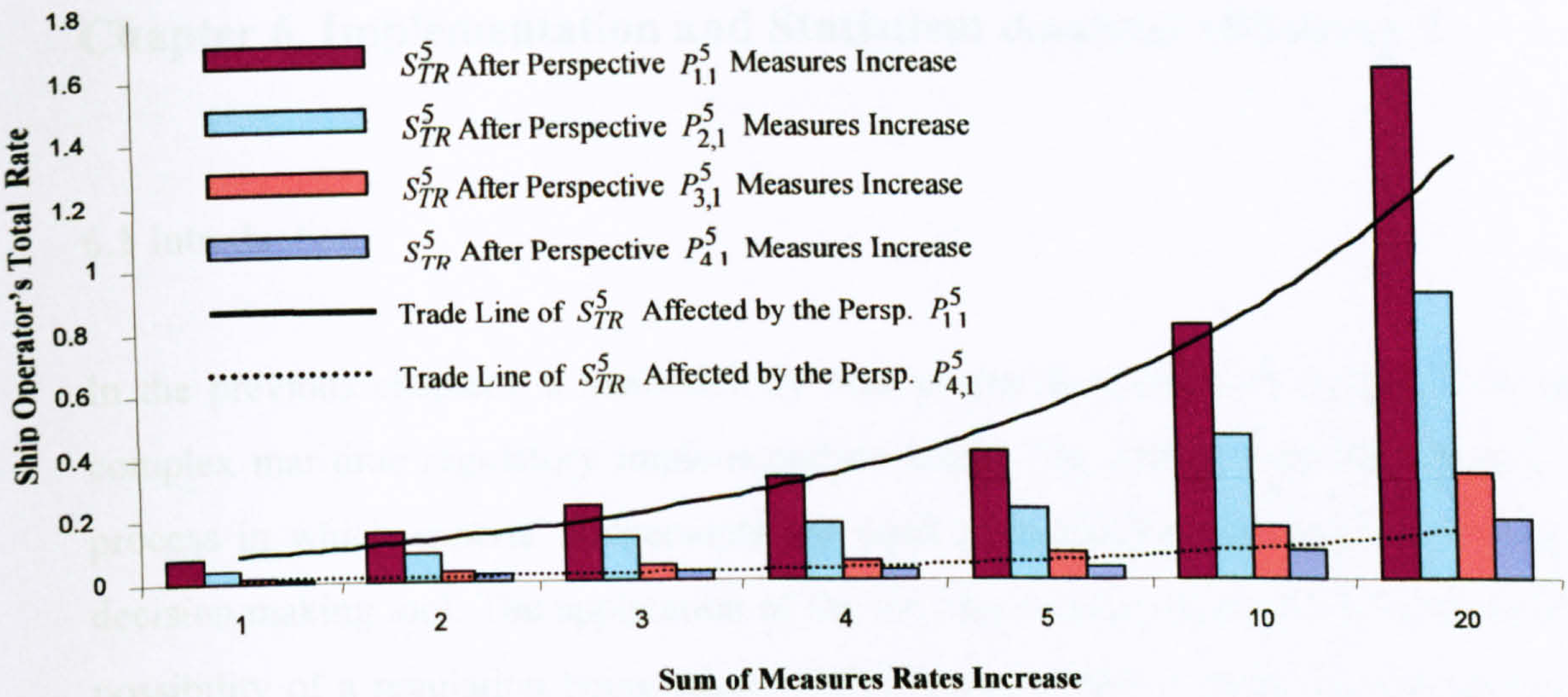

Figure 5.5. The Effect of Measures Increase to the Ship Operators' Total Rate

5.5 Conclusions

In this chapter two case studies were presented to show the wide applicability and potential limitations of the methodology and its tools. Furthermore, a validation was carried out to show the rationality of the methodology. From the above sensitivity analysis, it is clear that the proposed methodology, as it is mathematically expressed by Equation 19, is sensitive to small changes of input without causing any abnormality to S^5_{TR} such as ranking reversal and non-linear results.

Chapter 6. Implementation and Statistical Analysis of Survey 1

6.1 Introduction

In the previous chapters, a methodology was proposed capable of dealing with the complex maritime regulatory implementation issue. The designed methodology is a process in which experts' judgements are used as initial data in order to design a decision making tool. The application of the tool may assist regulators to evaluate the possibility of a regulation being successfully implemented. A decision can be made then if the regulation should be introduced or amended. Additionally it is suggested that a stakeholder may use the tool in order to measure his performance regarding the implementation of any regulation.

In this section, the applicability of the methodology and the designed tool is presented through a new case study. A survey was conducted through research questionnaires in which industrial experts had to verify the selection of the proposed BSCs and provide valuable feedbacks with regard to the regulatory authority of the representative stakeholders. Additionally, the experts had to evaluate the significance of the proposed divisions in a ship operator's organisation. The procedure and the findings of this survey are presented and analysed.

6.2 Develop a Questionnaire for Survey 1

A variety of books and guidelines have been reviewed before the construction of the questionnaire. From these sources three fundamental issues where revealed:

1. The questions in a survey should be simple and appropriate for the level of the participants (Houtkoop-Steenstra 2000).
2. The personal details of participants such as education and age may reveal different schools of thought (Bradburn and Sudman 1979).
3. The structure of a questionnaire should be developed in different parts each targeting a part of the research aims (Frazer and Lawley 2001).

A copy of this questionnaire is shown in Appendix 1. Its aim is to collect experts' opinions with regard to the evaluation of the industry and a selected stakeholder. These opinions will be used then to justify the rationality of the selected measures. Following the Delphi's method principle of anonymity, all experts' details are held confidentially.

The questionnaire was constructed in eight parts each one referring to a part of the research methodology. The first part included personal details of the experts in order to verify their academic and industrial background. These data are used afterwards for the evaluation of each expert's expertise. The second part is asking from each expert to evaluate in a scale of nine numbers the predefined linguistic terms as he uses them in his every day life. These linguistic terms are used by the expert in his answers in the rest of the questionnaire. The third part of the questionnaire included questions concerning the authority of the stakeholders of the industry. The expert should choose in a set of pairwise comparison to indicate how much a stakeholder is more important than another in a pair. The same approach is followed for the evaluation of the perspectives of each stakeholder. The fourth part of the questionnaire is asking from each expert to rate the proposed measures for validation of each measure. In a similar way with stakeholders pairwise comparisons are requested for the divisions of a ship operator between his divisions and the upper-level perspectives in parts five and six respectively. In the seventh part, the proposed measures for a ship operator are requested to be rated. Eventually the last part of the questionnaire is asking for comments with regard to the questionnaire.

6.2.1 Evaluation of Experts Knowledge

As it was indicated in literature review, the vague size of maritime regulations has caused confusion in the shipping industry. One way to study the depth of this confusion could be to measure the knowledge depth of the current regulatory system by the industrial experts. Up to date, there is not an acceptable standard to evaluate the knowledge of an expert for a specific topic (Weiss 2003), (Shantaeu et al 2002), (Cornelissen et al 2003). Therefore, five criteria from the above research are selected to evaluate the expertise of an expert (*Exp*) i.e. professional certification (*PCert*), academic certification (*ACert*), years of experience in shipping industry other than in managerial position (*Syears*) and years in managerial position (*Myears*) subject to consistency of an individual in answers. These criteria, which are listed in Table 6.1, were selected due to their simplicity to collect the data and their common acceptability.

Many researchers suggest that the consistency of an expert's answers is an indication of his expertise (Weiss 2003), Shantaeu et al 2002). Therefore, a further criterion that should be added is the consistency of an expert's judgements over the time. Weiss (2003) suggested that a key element to determine the expertise of an individual in a certain area is his ability to be consistent at his judgements. This consistency can be represented in the AHP theory by the *CR* value when an individual makes pairwise comparisons. To determine the *CR* value of a candidate in the proposed methodology the values of CR_1 and CR_2 are averaged as it is shown in Equation 20. The CR_1 value is the consistency of a candidate's pairwise comparisons for the shipping industry matrix and the CR_2 value is the consistency of his pairwise comparisons of the matrix of ship operator's divisions. Saaty suggests that if *CR* is computed by more than 0.2 then this is an indication that inconsistency is excessive and the pairwise comparison process should be revaluated. Thus, each candidate expert should satisfy Saaty's condition with $CR \leq 0.2$.

$$CR = \frac{CR_1 + CR_2}{2} \tag{20}$$

An index was developed in order to rank the available candidates for the needs of this research. Each criterion is rated from 1 to 5 as shown in Table 6.1, while the consistency of each individual's answers will be given from the *CR* value of the AHP calculations. The proposed criteria can be combined into Equation 21. The values of the proposed criteria can be multiplied to obtain an *Exp* value as shown in Equation 21. Hence, slight changes of the value of a criterion will change the *Exp* value a lot. However, the *CR* is reciprocal because it has a higher value when it is nearer to 0.

$$Exp = ACert \times PCert \times Syears \times Myears \times \frac{1}{CR} \tag{21}$$

Table 6.1. Scale of Experts Criteria

Rate	Academic Certification	Professional Certification	Managerial Experience	Shipping Industry Experience (Not Managerial)
5	PhD	Arbitrator	20 + years	20 + years
4	MSc	Ship surveyor/auditor	15- 19 years	15- 19 years
3	BSc	Captain / Chief Engineer	10-14 years	10-14 years
2	HND	Chief Officer/ 2nd Engineer	5-9 years	5-9 years
1	High School	Deck Officer/ Engineer	0-4 years	0-4 years

6.3 Implementation of Survey 1

Survey 1 was carried out in order to verify the proposed hierarchy and to collect information regarding the weight of each stakeholder in the regulatory process. According to the Delphi method that was chosen in this research a group of experts was chosen to validate the BSCs perspectives and measures through surveys. In order to ensure the reliability of this survey the questionnaires were distributed to a range of experts such as classification societies, shipping companies, academics and consultants from different countries. The first round of the Delphi method was replaced by the preparation of a questionnaire based on the literature review.

6.4 Survey results

In this section, the results from Survey 1 are discussed. Comparisons are made between the findings from the literature review, the initial hypotheses and the experts' opinions.

6.4.1 Experts Evaluation

After many months of chase, only eight experts responded to the survey, their qualifications and *CR*'s values are shown in Table 6.2. The answers from the experts pointed out that they ranked stakeholders and divisions differently. It is remarkable that although most of the experts hold a degree of higher education together with many years of experience there was a disagreement among them regarding the ranking of the stakeholders.

Table 6.2. Experts Experience

	CR_1	CR_2	CR	*ACert*	*PCert*	*Myears*	*Syears*	*Exp* (without considering CR)	*Exp*
Expert 1	0.352	0.419	0.386	3	4	5	3	180	466.93
Expert 2	0.8	0.51	0.655	4	4	4	4	256	390.84
Expert 3	0.312	0.293	0.303	1	3	2	5	30	99.17
Expert 4	0.402	0.251	0.327	4	4	4	2	128	392.04
Expert 5	0.28	0.21	0.245	3	4	3	3	108	440.82
Expert 6	0.444	0.65	0.547	1	4	3	5	60	109.69
Expert 7	0.385	0.848	0.617	4	3	2	3	72	116.79
Expert 8	0.489	0.381	0.435	5	3	1	5	75	172.41

The analysis of expert judgements shows that the ranking of experts according to their qualifications is not linked with the consistency of their answers. In Table 6.3 the ranking of the experts according to the *CR*, their qualifications and experience may vary significantly. For instance, Experts 5 has the lowest *CR* in his answers although his qualifications and experience rank him higher than all the other experts. This result verifies the suggestion of Saaty (1994) that in group decision making the *CR* of individuals is not important. In contrast, the *CR* of the entire group should be considered of high importance.

For further analysis the experts were separated in three groups in order to select the group with the most valuable experts. The experts' groups can be seen in Table 6.4 are: first all of them, secondly the five experts with the lowest *CR* values and thirdly the five experts with the highest *Exp* values. In every group, the ranking order of the divisions is different than the other two groups. However, all the three groups chose the same divisions in the first five ranks, which are Managing Director, Operation Department, Chartering Department, Technical Department and ISM Department. Additionally none of the groups ranks the remaining divisions, which are the Accounting Department, Crew Department, ISPS Department, Ship or Supply Department, higher than the fifth ranking position.

Table 6.3. Ranking of Experts

Rank	Best *CR*		*Exp* (without considering CR)		*Exp*	
1	Expert 5	0.245	Expert 1	466.93	Expert 2	256
2	Expert 3	0.302	Expert 5	440.82	Expert 1	180
3	Expert 4	0.326	Expert 4	392.04	Expert 4	128
4	Expert 1	0.385	Expert 2	390.84	Expert 5	108
5	Expert 8	0.435	Expert 8	172.41	Expert 8	75
5	Expert 6	0.547	Expert 7	116.79	Expert 7	72
7	Expert 7	0.616	Expert 6	109.69	Expert 6	60
8	Expert 2	0.655	Expert 3	99.17	Expert 3	30

Table 6.4. Ranking of Divisions

Rank	All Experts		5 best in *CR*		5 best in *Exp*	
1	Managing Director	0.275	Managing Director	0.221	Managing Director	0.255
2	Operation Department	0.174	Operation Department	0.166	Technical Department	0.172
3	Chartering Department	0.144	Technical Department	0.166	Operation Department	0.153
4	Technical Department	0.141	ISM Department	0.165	ISM Department	0.145
5	ISM Department	0.061	Chartering Department	0.066	Chartering Department	0.063
6	Accounting Department	0.057	ISPS Department	0.062	ISPS Department	0.057
7	Crew Department	0.051	Accounting Department	0.048	Accounting Department	0.052
8	ISPS Department	0.044	Crew Department	0.046	Crew Department	0.041
9	Ship	0.031	Ship	0.036	Ship	0.040
10	Supply Department	0.022	Supply Department	0.023	Supply Department	0.022

The results from the above analysis verify that the people who work in the shipping industry are confused about the regulatory authority of each stakeholder and/or his contribution to the current system. Furthermore, the inconsistencies between their answers suggest that there are not clear boundaries regarding the contribution of each division in the regulatory compliance of a ship operator's company. The contribution of the proposed *Exp* index and *CR* are significant in this research because they pointed out the confusion among industrial experts for regulatory issues. However, they cannot be used as decision factors for the selection of the most valuable experts. Consequently, all the eight experts are used for further analysis.

6.4.2 Evaluation of Linguistic Terms

Each expert was asked to evaluate every linguistic term by giving the lower, the upper and the most possible values in a range from 1 to 9. By using Equation 10, the nine linguistic terms were calculated as they are shown in Table 6.5, and graphically represented in Figure 6.1.

In this process, the experts found some challenges while dealing with the issue of evaluating linguistic terms. Initially they claimed difficulty to understand the meaning of a linguistic term. A further difficulty they had was to evaluate each linguistic term in a scale of nine numbers. It was necessary to send many samples and to arrange many interviews with experts in order to explain and clarify what they were requested to do. Eventually most of the experts argued that a numerical scale would be easier for them than the scale of linguistic terms.

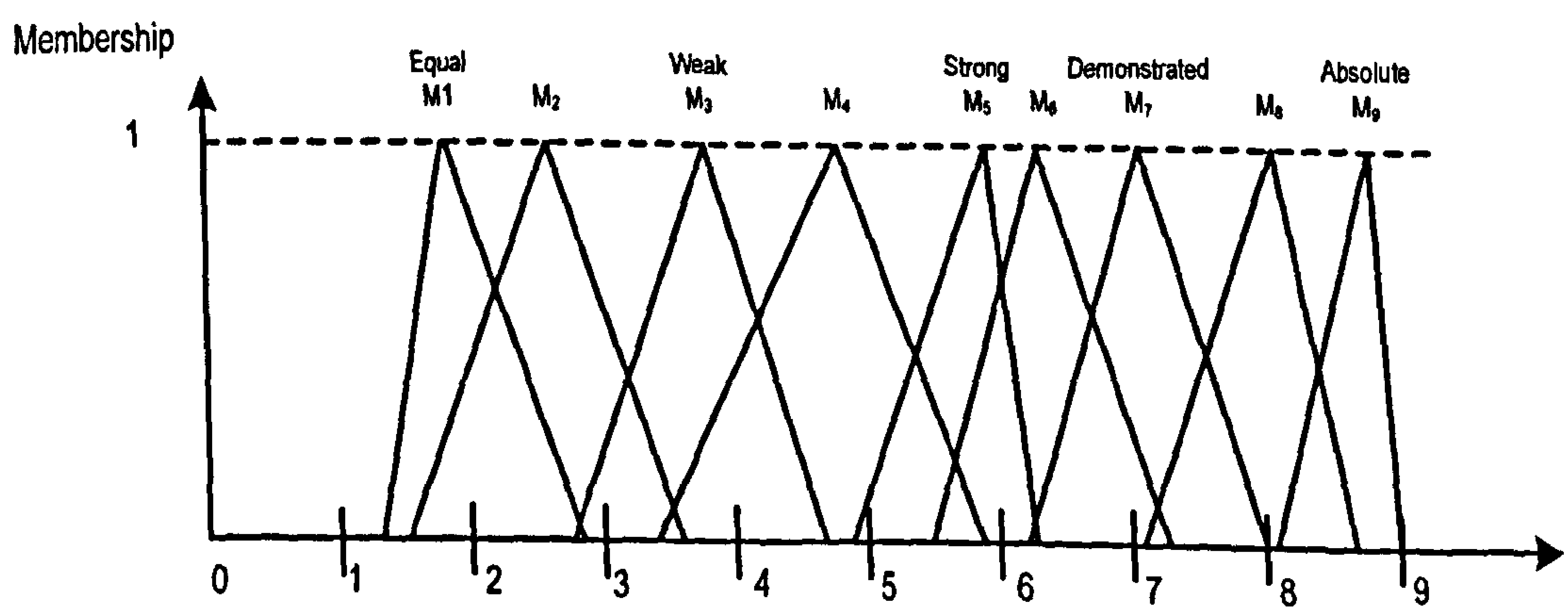

Figure 6.1. The Calculated Membership Functions of the Nine Linguistic Terms

Table 6.5. The 9-Point Scale of AHP with Calculated Fuzzy Numbers

Intensity of Membership Importance	Fuzzy Number	Definition	Membership Function
1	$\widetilde{M}_1$	Equal Importance	(1.250, 1.750, 2.750)
2	$\widetilde{M}_2$	Equal to Weak Importance	(1.625, 2.750, 3.750)
3	$\widetilde{M}_3$	Weak Importance	(2.750, 3.750, 4.625)
4	$\widetilde{M}_4$	Weak to Strong Importance	(3.375, 4.750, 5.875)
5	$\widetilde{M}_5$	Strong Importance	(4.875, 5.875, 6.625)
6	$\widetilde{M}_6$	Strong to Demonstrated Importance	(5.500, 6.375, 7.250)
7	$\widetilde{M}_7$	Demonstrated Importance	(6.250, 7.125, 8.000)
8	$\widetilde{M}_8$	Demonstrated to Extreme Importance	(7.125, 8.125, 8.625)
9	$\widetilde{M}_9$	Extreme Importance	(8.125, 8.750, 9.000)

6.4.3 Analysis of the Stakeholders

The fuzzy numbers from Table 6.5 were used to measure the expert judgements. The fuzzy numbers were averaged by using Equations 6 and 7 and defuzzified to crisp numbers with Equation 9. For the stakeholders a matrix was designed, as shown in Table 6.6, and λ_{max} was calculated to be 12.13 by using Equation 5. The *CR* was calculated from Equations 3 and 4 to be 0.159. Consequently there is a consistency for the fuzzy matrix of the stakeholders which is little above the limit $CR \leq 0.1$. It should be noted that in real world it is often difficult to reduce the *CR* to less than 0.1 due to the complexity of the real situations and because of the unwillingness of some experts to change their opinion in favour of what other experts believe. Furthermore, as it was explained in Section 4.2.2 Saaty clarified that the value of *CR* in some cases could be up to 0.2. and further attempts to improve the consistency will not necessarily provide a more pragmatic answer. Therefore, the obtained *CR* value is considered acceptable here.

Table 6.6. Stakeholders' Fuzzy Matrix

	S^1	S^2	S^3	S^4	S^5	S^6	S^7	S^8	S^9	S^{10}
S^1	1.000	6.021	5.319	5.745	5.157	4.573	5.745	6.156	4.641	4.488
S^2	0.168	1.000	3.859	4.187	4.921	3.149	4.911	4.520	3.925	3.308
S^3	0.189	0.263	1.000	3.113	2.487	2.986	5.682	5.863	4.943	1.793
S^4	0.177	0.245	0.335	1.000	0.458	0.476	2.306	0.262	0.551	1.237
S^5	0.196	0.207	0.407	2.241	1.000	5.484	5.615	5.645	3.900	4.450
S^6	0.225	0.327	0.347	2.158	0.185	1.000	0.650	0.582	0.331	2.111
S^7	0.177	0.208	0.179	0.468	0.181	1.581	1.000	2.871	1.122	0.619
S^8	0.164	0.226	0.172	3.964	0.180	1.834	0.356	1.000	1.676	1.923
S^9	0.221	0.260	0.207	1.846	0.262	3.109	0.953	0.638	1.000	1.538
S^{10}	0.226	0.308	0.589	0.850	0.228	0.491	1.777	0.546	0.708	1.000

Equation 2 was used to determine the weights of each stakeholder in the stakeholders' matrix. The stakeholders' weighting is shown in Table 6.7 in a ranking order. From the results of Table 6.6 it appears that according to the experts, the most important stakeholder in the regulatory process is the flag state followed by the coastal state, the classification society and the ship operator. It is notable that the aggregated weight of these four stakeholders is equal to 0.738, while all the other six stakeholders' weights aggregated 0.262. The significance from the relevant weight of each stakeholder indicates how a stakeholder can be more important than another in the implementation process.

Following a further analysis of the stakeholders' ranking in terms of significance in the implementation of a maritime regulation some very important issues are revealed. First, it is clear that states have a major role in the regulatory process. Although the classification societies have been criticised for their efficiency in the past there is a strong belief that their contribution in the regulatory process is very important. Among the private stakeholders, the weight of the ship operator is significantly higher than the others. A ship operator is probably the first individual that will be criticised in a case that one of the ships that he manages is involved in an incident. His high weight may justify this criticism because he has a significant role in maintaining his ships safe by complying with maritime regulations. On the other hand, it is shown that ship operators cannot take the entire burden for the current regulatory standards in the shipping industry. It is also noteworthy that all the other private stakeholders have comparatively small weights. Therefore, it can be assumed that their contribution in the implementation of maritime regulations is significant but not deterministic. Eventually the results of the crew members' role are valuable for this analysis. Crew members are listed last in the ranking order with a relatively small weight. Hence, it is shown that their contribution in the regulatory implementation is of low significance. This opinion is in conflict with other industries such as nuclear and aviation where the skills of their personnel relating to education, training and safety culture are highly prioritised.

Table 6.7. The Weighting of Stakeholders

Stakeholder	Weight	Rank
Flag State S^1	0.303	1
Coastal State S^2	0.175	2
Classification Society S^3	0.129	3
Ship Operator S^5	0.127	4
Ship Builder S^8	0.055	5
Cargo Owner S^9	0.051	6
Underwriter S^6	0.043	7
Marine Consultant S^7	0.041	8
P&I S^4	0.039	9
Crew members S^{10}	0.038	10

6.4.4 Analysis of the Stakeholders' Perspectives

At Survey 1, the weights of the stakeholders and their perspectives are determined from experts' judgements. To obtain the importance of each perspective to the implementation performance of a maritime regulation, the perspectives weights are multiplied by the weight of their parent stakeholders. The overall ranking of all the stakeholders' perspectives is shown in Table 6.8 where in second column on the left side provides the weight of the overall financial perspective's priority of each stakeholder. For instance, the weight of the finance perspective of the flag state is 0.128. In a similar way to the first column the other overall perspectives weights are shown. The sum of each of each column in the last row provides the total weight of each perspective in the regulatory process.

Table 6.8. Overall Priority of Stakeholders' Perspectives

Stakeholder	**Finance Perspective**	**Customer Perspective**	**Learn & Growth Perspective**	**Internal Perspective**
Flag State	**0.128**	**0.063**	**0.061**	**0.054**
Coastal State	**0.058**	**0.061**	**0.028**	**0.028**
Classification Society	**0.044**	**0.045**	**0.029**	0.011
P&I	0.017	0.011	0.004	0.005
Ship Operator	**0.069**	**0.027**	0.011	**0.020**
Underwriter	**0.022**	0.009	0.004	0.008
Marine Consultant	0.016	0.013	0.005	0.006
Ship Builder	**0.031**	0.014	0.004	0.007
Cargo Owner	**0.028**	0.012	0.004	0.006
Crew members	0.018	0.005	0.009	0.004
Total	0.431	0.260	0.160	0.149

Some very interesting conclusions are drawn from this ranking about the priorities of each stakeholder. A generic conclusion is that stakeholders are more concerned of issues such a finance and customer satisfaction than issues of internal business and learn & growth. This is an indication that the economic consequences that a stakeholder may suffer by implementing a regulation are more important for him than his ability and knowledge required to implement successfully the regulation.

A notable finding from Table 6.8 is that the financial perspectives from flag and coastal states are very important compared to their other perspectives. The financial perspective is based mainly on the customer perspective. If the weights of the states' financial and customer perspectives are aggregated then it appears that for the states the economic consequences that they may suffer by implementing a regulation are of high importance. In a similar way it is can be found that the classification societies are concerned for their customers and finance more than the other perspectives.

It is also of high importance to highlight the low weighting of the private stakeholders. At the same time, it is notable that the ship operator has a high weight as an exception. In the contrary flag and coastal state are ranked on the top of the list. This could be an indication that there is still a strong belief among the experts that states can make the difference in the regulatory environment. However, in the analysis of the perspectives it is clear that the participation of every stakeholder in the regulatory process is vital because of their weighting is low but significant.

A further issue that is shown in Table 6.8 is that the perspectives weights are not balanced. Among all the perspectives seventeen are higher ranked, which are printed in bold type. These seventeen perspectives aggregate a weighting of 0.796, which is an indication that they should be considered of high importance that they should be satisfied with priority by any regulation.

6.4.5 Analysis of the Ship Operator

The experts were requested to evaluate a ship operator's performance S^c_{TR} in a scale from 0 to 10. Table 6.9 shows the relation between the rate of a ship operator and his performance. All experts agreed that for a stakeholder the implementation of regulations is of high importance. Therefore, in this research it is suggested that the aim of a ship operator should be to achieve at least the lowest rate of high performance, which is 7. However, the long-term target of a ship operator is to achieve a performance rate equal to 10.

In a similar way to the procedure that was followed with stakeholders the expert judgements were used to form a comparison matrix for the divisions of a ship operator. The *CR* was calculated 0.12 which is considered to be acceptable as valid because is below the 0.2 limit. The weighting of all the divisions is shown in Table 6.10. From the results of Table 6.10, it appears that the most importantly ranked division in the regulatory process is the Managing Director followed by the Operation

Department, the Technical Department and the ISM Department. These four divisions are so important that their weights sum 0.734. All the other six divisions have a total weight equal to 0.166. The relevant weight of each division indicates its importance in the implementation process for a ship operator.

Table 6.9. The Rating of Measures

Rate	Definition
9-10	Very High Performance
7-8	High Performance
4-6	Medium Performance
2-3	Low Performance
0-1	Very Low Performance

Table 6.10. The Weighting of Divisions

Division	Weight	Rank
Managing Director	0.275	1
Operation Department	0.174	2
ISM Department	0.144	3
Technical Department	0.141	4
Chartering Department	0.061	5
ISPS Department	0.057	6
Crew Department	0.051	7
Accounting Department	0.044	8
Ship	0.031	9
Supply Department	0.022	10

For a ship operator it was necessary to rank his divisions' perspectives regarding their weighting in order to assess his benefits from a regulation in more detail. From the overall ranking of the perspectives in Table 6.11 a main conclusion which can be obtained is that the perspective with the highest weighting for the divisions to implement a regulation is the financial perspective, followed by the customer perspective, learn & growth and finally the internal business. As it is shown from the perspective's overall ranking a ship operator is more concerned about the cost reduction that can be achieved to each department by the implementation of a new regulation. The difficulties in executing the regulation and to know how he will improve his organisation appear to be of low priority for him.

From the analysis it is clarified that the departments may have different priorities between themselves as in the case of the ISM Department where the customer perspective is ranked higher than the financial perspective. This is reasonable as the ISM Department, treats issues involving safety and pollution prevention more importantly than the cost reduction.

It is notable that the perspectives' weights are not balanced. Therefore, the first thirteen higher ranked perspectives, which are printed in bold type in Table 6.11, aggregate a weighting of 0.729. This is an indication that these thirteen perspectives should be considered of high importance for a ship operator while the others should be used for a detailed analysis of the same company.

Table 6.11. Overall Priority of Divisions and their Perspectives

Division	Financial	Customer	Internal Business	Learn & Growth
Managing Director	**0.159**	**0.063**	**0.026**	**0.027**
Operation Department	**0.087**	**0.057**	0.015	0.014
Technical Department	**0.065**	**0.043**	0.014	0.018
ISM Department	**0.031**	0.018	0.005	0.007
Chartering Department	**0.034**	**0.047**	**0.048**	0.015
Accounting Department	**0.027**	0.009	0.003	0.005
Crew Department	0.019	0.019	0.007	0.006
ISPS Department	0.011	0.021	0.015	0.009
Ship	0.014	0.008	0.005	0.004
Supply Department	0.013	0.005	0.002	0.003
Total	0.460	0.289	0.142	0.109

6.5 Conclusions

The analysis of Survey 1 verified many of the initial hypotheses stated in this research. First, it was demonstrated that the effect of a maritime regulation to the shipping industry could be investigated. By analysing four fundamental management issues such as financial and customer perspective of main stakeholders it was possible to rank these issues and reveal the burdens of a regulation and how severe each burden could be. Eventually it was shown that industrial experts may not be clear about the authority that each stakeholder has in the regulatory process.

Chapter 7. Implementation and Statistical Analysis of Survey 2

7.1 Introduction

In this chapter, it is presented the implementation of a second round survey, Survey 2. The scope of the survey is to test the second tool of the proposed methodology for its applicability. Due to the vast size of the shipping industry, the ship operator among the stakeholders is selected and a tool is designed for a typical company. This tool, which was based on the results of Survey 1, is sent in a form of questionnaire to many ship operators asking them to self evaluate their performance with regard a chosen maritime regulation. The results of the survey and the applicability of the tool are then discussed.

7.2 Develop a Questionnaire for Survey 2

From the questionnaires of Survey 1 it was possible to calculate the weighting of each stakeholder in the regulatory process. Nevertheless, it is necessary for a second round survey to be carried out to test the applicability of the methodology to a stakeholder. The experts approved all elements of the proposed BSCs of Chapter 4. This caused a difficulty because the second questionnaire would be seen as somewhat excessive by its inclusion of 160 questions, which a company will have to answer. It is therefore necessary to limit the number of the questions as much as possible.

This proposed reduction is also practical because for a manager it is of high significance to be able to have accurate and fast results of his company's performance with a minimum effort. Otherwise, he is uncertain about the level of risk that he is exposed until all the 160 measures are assessed. An indication for possible failures at the early stages of implementing a regulation can help a manager to make a decision if any corrective or additional actions are required. Therefore, the proposed stakeholder's tool should be simplified and be capable of identifying potential errors of implementation performance in a fast and accurate manner.

The core of the proposed tool is the AHP method. It is well recognised that such a method requires many calculations whenever it is necessary to deal with large hierarchical structures. A possible solution to this problem is to use complicated and expensive software programs, which are available on the market. However, Harker (1987) suggested that it is not necessary to make all calculations because the importance of an element can be identified with a selective number of comparisons. With respect to the problem of fast decision making Gigerenzer (1996, 2007) suggested that in decision making problems where lack of both time and expertise exist it may be useful to examine a single criterion each time until all criteria are met. When there is evidence that one of the criteria is unsuccessfully met then corrective actions should be taken. In this research, it is suggested that the order of the criteria examined should follow a ranking order according to their importance.

In addition to the above suggestions, the sensitivity analysis study in Section 5.4 revealed that the contribution of the highly ranked divisions and perspectives to the total rate of a stakeholder is more significant than those lower ranked. In this aspect, the tool may be used in a scanning process where the stakeholder is examining if the highly ranked divisions and perspectives can deliver a high performance. If this test fails then there is no need to examine the lower ranked divisions and their perspectives.

7.3 Calculating the Number of Minimum Questions

The first concern in minimizing the measures of the hierarchy for a ship operator is to calculate the acceptable values that each measure, perspective and division should achieve. Equation 19 can be rewritten as a sum of division rates as below:

$$S_{TR}^{c} = RD_{1}^{c} + RD_{2}^{c} + RD_{3}^{c} + ... + RD_{u}^{c} \qquad (22)$$

In Equation 22 each RD_{u}^{c} can be replaced by its weights wD_{u}^{c} and its performance rates pD_{u}^{c} as follows:

$$S_{TR}^{c} = wD_{1}^{c} \times pD_{1}^{c} + wD_{2}^{c} \times pD_{2}^{c} + ... + wD_{u}^{c} \times pD_{u}^{c} \qquad (23)$$

In order to identify the most valuable divisions with the highest weights lets assume that there is a division value RD_x^c where after that all other divisions' contribution is numerically insignificant. Hence, Equation 23 will be:

$$S_{TR}^c = wD_1^c \times pD_1^c + wD_2^c \times pD_2^c + ... + wD_x^c \times pD_x^c + ... + wD_{u-1}^c \times pD_{u-1}^c + wD_u^c \times pD_u^c$$

Since the lower ranked divisions' contribution may be numerically insignificant even if they excel, the pD_u^c values can be replaced by the value 10 which is the highest value that can be achieved by any division:

$$S_{TR}^c = wD_1^c \times pD_1^c + wD_2^c \times pD_2^c + ... + wD_x^c \times pD_x^c + ... + wD_{u-1}^c \times 10 + wD_u^c \times 10 \Rightarrow$$
$$S_{TR}^c = wD_1^c \times pD_1^c + wD_2^c \times pD_2^c + ... + wD_x^c \times pD_x^c + 10\left(wD_{x+1}^c + ... + wD_{u-1}^c + wD_u^c\right)$$

It is known that the sum of all the weights is equal to 1. The sum of the smaller weights can be found from deducting their sum from the value 1. Hence, Equation 22 can be rewritten:

$$S_{TR}^c = wD_1^c \times pD_1^c + wD_2^c \times pD_2^c + ... + wD_x^c \times pD_x^c + 10\left(1 - wD_1^c - wD_2^c - wD_x^c\right)$$

The stakeholder must consider which should be the lowest acceptable value M for each division's performance. However, it is obvious that this value should not be less than 5, which is half of the maximum and desired achievement.

$$S_{TR}^c = wD_1^c \times M + wD_2^c \times M + ... + wD_x^c \times M + 10\left(1 - wD_1^c - wD_2^c - wD_x^c\right) \Rightarrow$$
$$S_{TR}^c = M(wD_1^c + wD_2^c + ... + wD_x^c) + 10 - 10(wD_1^c + wD_2^c + wD_x^c) \Rightarrow$$
$$S_{TR}^c - 10 = (wD_1^c + wD_2^c + ... + wD_x^c)(M - 10) \Rightarrow$$
$$M = \frac{S_{TR}^c - 10}{wD_1^c + wD_2^c + ... + wD_x^c} + 10 \qquad (24)$$

The above equation shows the relationship between the stakeholder performance S_{TR}^c and the sum of the highly ranked divisions' weights when all the other divisions excel. As was revealed by the expert judgements S_{TR}^c should have a minimal value of 7 although other stakeholders may choose another higher value. It is calculated that the four highly ranked divisions (See Table 6.10) where their weights sum 0.734 should have a minimum performance rated with 5.91 and that all the other divisions with a total weight equal to 0.266 should all be valued with 10 in order to achieve performance equal to 7.

From the above calculations, it is shown that by examining hierarchically the organisation of a company every time that the performance of a division is lower than the value 5.91 it is harder for the company to achieve a S^{c}_{TR} value higher than 7. Therefore, by checking hierarchically a company with the above process it is possible to have a fast indication about the company's performance without needing to check all the 160 proposed measures.

7.4 Perspectives' Selection

In a similar way, the stakeholder performance can be evaluated from its higher weighted perspectives. By adopting this approach, a number of measures can be chosen from a wider area than the higher ranked divisions as it was proposed at Section 7.3. The values from Table 6.11 can be represented in Figure 7.1. As it can be seen from Figure 7.1 the weights of thirteen perspectives are significant higher than the others. This is in conjunction with the sensitivity analysis that was carried out at Chapter 4 where it was found that the values of the perspectives with the highest weights are determinative for the Total Rate of an organisation. Furthermore, these thirteen highly ranked perspectives sum 0.714 of the total weight. As it was shown in the previous section if an organisation fails to achieve a minimum acceptable value it will be very difficult for the organisation to achieve a high Total Rate.

The S^{c}_{TR} value can be calculated in connection with perspective rates $RP^{c}_{a,u}$ by Equation 18. Following a similar procedure as described in Section 7.3, two conditions should be satisfied in order to determine a minimum average value of each highly ranked perspective P_{avg}. First, the twenty-seven lower ranked perspectives that aggregate 0.296 of the total weight achieve excellence. Secondly, the S^{c}_{TR} should be no less than 7. Then the minimum P_{avg} can be calculated as below:

$$P_{avg} = \frac{S_{TR}^{c} - 10}{owP_{a,u}^{c} + ... + owP_{n,m}^{c}} + 10 = \frac{7 - 10}{0.714} + 10 = -4.21 + 10 = 5.79 \quad (25)$$

where $owP_{a,u}^{c}$ is the overall weight of a perspective.

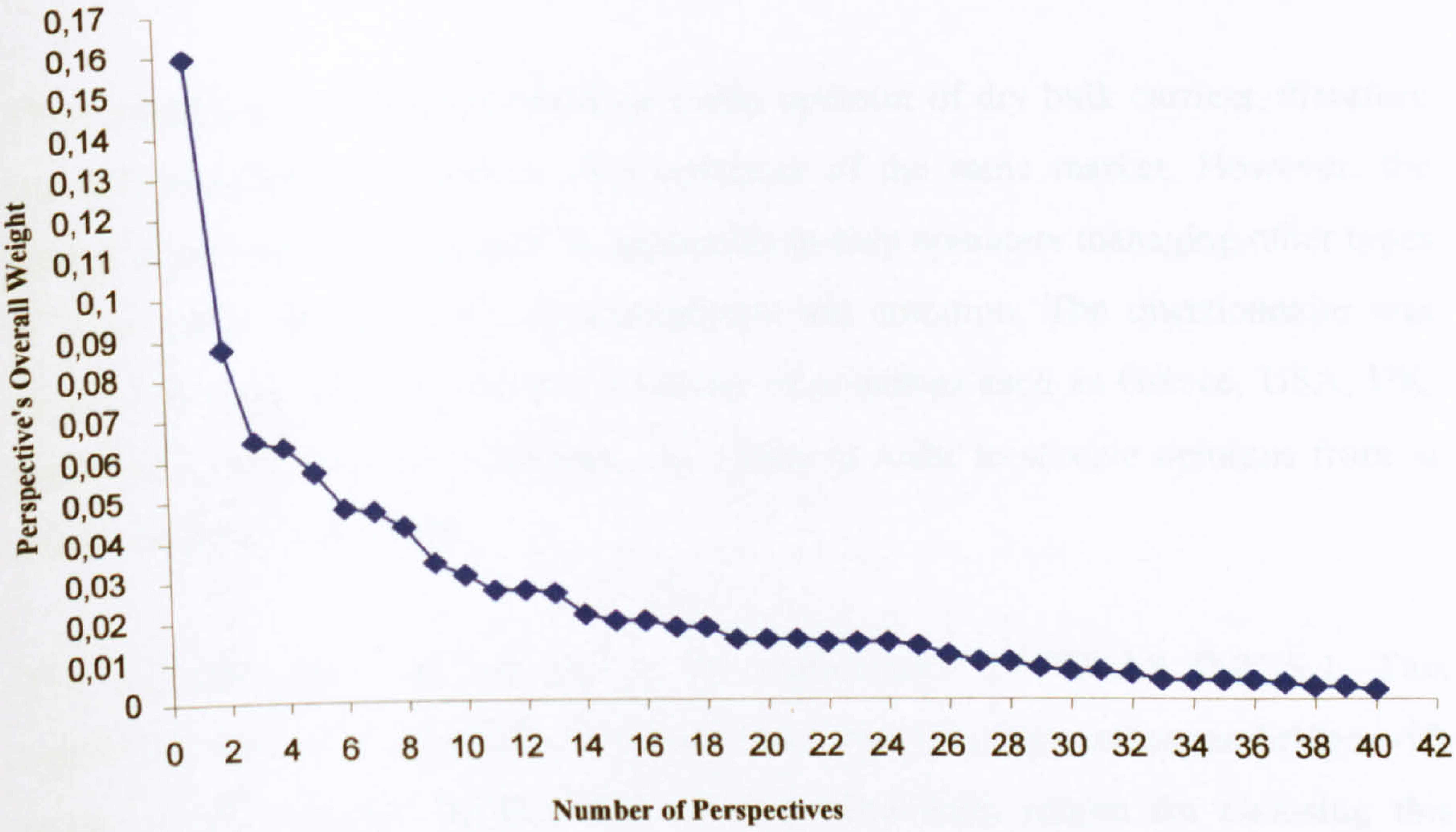

Figure 7.1 A Graphically Representation of a Ship Operator's Overall Perspectives

Therefore, each of the thirteen higher ranked perspectives should achieve an average value of 5.79. Otherwise, even if all the other perspectives excel the ship operator will not achieve a high performance. By adopting this approach, it is possible to narrow the length of the second questionnaire to forty-eight questions, which correspond to the measures of the thirteen higher ranked perspectives.

7.5 Implementation of Survey 2

Survey 2 has a different purpose from Survey 1, therefore a different approach was used. Survey 2 is a checklist where each question is a measure and it is requested from ship operators to indicate their performance. The ideal situation would be that the correspondents could provide answers based on real data such as the number of accidents or the percentage of various costs that they suffered. However, it was expected that no ship operator would release such kind of information even if they were available. Due to the low number of answers, the survey was sent to a major classification society. By using this approach, a classification society with knowledge about the challenges and potentials of hundreds of ship operators provided valuable feedbacks. These feedbacks were used in order to make comparison with the results from the ship operators.

The methodology is designed based on a ship operator of dry bulk carriers, therefore the questionnaires were sent to ship operators of the same market. However, the design of the methodology could be applicable to ship operators managing other types of ships since the principles of management are common. The questionnaire was emailed to many ship operators in a variety of countries such as Greece, USA, UK, Australia, Japan, Norway, Germany, and China in order to receive opinions from as many countries as possible.

The regulation that was selected is the requirement of SOLAS II-2/19.1. This regulation states that deck officers should have available information on bridge with regard to the damage stability of their ship. The main reason for choosing this regulation is that it is quite simple without involving complicated calculations and further reading. On the other hand, some studies are required which should be followed by additional training. In addition, the regulation is concerned about an emergency and it is very interesting to investigate how companies respond to such regulations.

The questionnaire for Survey 2 is shown in Appendix 2. It consists of five parts in order to gather appropriate information. Part one includes instructions for the responders. In part two and three some information are requested regarding the size of the company and the responder's qualifications respectively. Part four includes the chosen measures that should be evaluated by the companies. Eventually the fifth part is requiring additional comments regarding the questionnaire.

7.6 Survey Results

After many reminders and phone calls, only four ship operators and one classification society responded with valid questionnaires. Most of them are based in Greece although it was attempted to have a broader geographical representation. The results are grouped into two sections below, one for the ship operator and one for his divisions.

7.6.1 Analysis of the Ship Operator's Performance

The S_{TR}^{c} value of each ship operator indicates what they would achieve if they measure their implementation performance with the proposed tool. The ship operators that participated in Survey 2 believe that they will have a low implementation performance in this regulation. The S_{TR}^{c} values are in a range of 2 and 3.8. As it was shown in Section 7.4 if a ship operator fails to achieve the minimum P_{avg} value of 5.79 then even if he achieves a value of 10 in all the other measures, which do not appear in the Survey 2, he cannot obtain S_{TR}^{c} equal to 7. Hence, his performance cannot be higher than medium by reference to Table 6.9. It is expected that if a ship operator had to follow the 160 proposed measures in Chapter 4 then more weaknesses of the implementation process would be revealed.

7.6.2 Findings for the Ship Operator's Divisions

The next step of analysis is to compare the division rates of each Ship Operator in order to find which divisions face the most challenges. A list of the performance of the ship operators' divisions is shown in Table 7.1. In this table, it is shown that the ship operators agree about how their divisions can perform by implementing the regulation for damage stability information.

From Table 7.1 a variety of conclusions can be obtained. The first conclusion is that all the divisions' rates are much less than the minimum values that should be achieved. Additionally, there is an imbalance of performance between the divisions. Therefore, the regulation implementation is believed to be challenging for most of the divisions. A second important conclusion is that the classification society's opinion is that the ship operators can achieve higher performance values than the ship operators believe.

A possible explanation for this difference could be the fact that the ship operators are more negative to additional regulations. Another explanation may be that there is some distance between classifications societies and ship operators with regard to their abilities of the later.

The ship operators' perspectives and divisions' rates are calculated by using the measures rates from the Survey 2 and equations 16, 17 and 18. These results are shown at Table 7.1 where for each correspondent operator three columns are displayed indicating from the left to the right his rates perspectives' rates, division's performance and the divisions' rate respectively. For instance for the ship operator 1 the value of the managing director's financial perspective is 0.868. For the same ship operator the performance of his division is 2.264 and the division's rate is 0.623 which are shown in the second and third column respectively.

For some divisions the rates could not be much higher even if the regulation had less requirements since the improvement of safety is costly and time consuming. However, a small increase could make a difference. It is of high importance to underline that the results would be more accurate if the ship operators could provide numerical data such as the amount of money spent or the number of failures related to the regulation. Hence it is fairly reasonable to say that the opinions of the correspondents may be more negative than the real situation is.

For further analysis it is important to compare the perspectives, which are listed in Table 7.2 since the checklist was designed based on perspectives for more accuracy. The three perspectives, which achieved the higher values, are the customer from the division of Managing Director, customer from the division of Operation Department and customer from the division of ISM Department. This is an indication that the ship operators understand that their compliance with damage stability regulation is something that will improve their public image to many of the other stakeholders. In contrast, the three perspectives with the lower values are the financial from the division of Managing Director, financial from the division of the ISM Department and the financial from the division of Technical Department. This is an indication related to the cost that the regulation will produce to the ship operators. This is a verification of the hypothesis 2 that even a small improvement on ships safety can be very costly for a ship operator.

Table 7.1 Summary of Ship Operators' Results

	Ship Operator 1			Ship Operator 2			Ship Operator 3			Ship Operator 4			Class Society		
	$RP^c_{a,u}$	pD^c_u	RD^c_u	$RP^c_{a,u}$	pD^c_u	RD^c_u	$RP^c_{a,u}$	pD^c_u	RD^c_u	$RP^c_{a,u}$	pD^c_u	RD^c_u	$RP^c_{a,u}$	pD^c_u	RD^c_u
M. Director															
Financial	0.868			1.447			1.447			2.315			1.447		
Customer	0.630			1.318			1.662			1.604			2.006		
Internal Business	0.318	2.264	0.623	0.416	3.675	1.011	0.489	3.833	1.054	0.612	4.908	1.350	0.514	4.343	1.194
Learn & Growth	0.447			0.494			0.235			0.377			0.377		
Operation															
Financial	1.506			1.757			1.130			2.511			2.009		
Customer	1.148	2.654	0.462	1.968	3.725	0.648	1.640	2.769	0.482	2.460	4.970	0.865	2.951	4.960	0.863
Technical															
Financial	1.387	2.380	0.343	1.618	3.603	0.519	0.578	1.876	0.270	1.965	4.332	0.624	1.733	4.330	0.624
Customer	0.993			1.986			1.298			2.367			2.596		
ISM															
Financial	0.651			0.651			0.710			0.710			0.769		
Customer	1.135	2.786	0.393	0.973	2.873	0.405	3.082	5.458	0.770	3.082	5.458	0.770	2.839	5.690	0.802
Learn & Growth	1.000			1.250			1.666			1.666			2.083		
Chartering															
Financial	1.385	1.385	0.084	1.636	1.636	0.100	1.259	1.259	0.077	3.273	3.273	0.200	3.399	3.399	0.207
Acc./Fina.															
Financial	1.207	1.207	0.053	1.207	1.207	0.053	1.508	1.508	0.066	4.072	4.072	0.179	4.223	4.223	0.186

It is also noteworthy that the perspectives of internal business and learn & growth which appear in the Managing Director and the ISM divisions have average values between 4 and 4.9. This may mean that the regulations do not produce an excessive workload for the ship operators. The requirements of regulation are very simplified, however still the performance values are relatively low. These results could be different if the regulation in Survey 2 was the one that required new procedures such as ballast water management or the ISPS Code.

At Survey 2, four ship operators and one class society rated their efficiency in implementing the regulation of damage stability for each measure. A summary of the correspondent ship operators' measures rates are shown in Table 7.2. Every column provides the measure rates that the ship operator of the same column achieved for the measure of the same row. For instance at the third row in the second column it is written the value 1.5. This value is the Financial perspectives' rate for ship operator 1.

Table 7.2. Summary of Ship Operators' Measure Rates

	Ship Op.1	Ship Op.2	Ship Op.3	Ship Op.4	Class
Managing Director					
Financial	**1.5**	**2.5**	**2.5**	**4**	**2.5**
Increase income.	1	7	7	7	7
Decrease capital cost.	1	1	1	3	1
Reduce administration costs.	1	1	1	3	1
Minimize the need for immediate cash to meet regulations requirements.	3	1	1	3	1
Customer	**2.75**	**5.75**	**7.25**	**7**	**8.75**
Reduce off hire days.	1	6	7	7	7
Increase reputation and credibility.	4	6	10	7	10
Improve quality of ship's activities.	5	6	4	6	9
Reduce the number of claims.	1	5	8	8	9
Internal Business	**3.25**	**4.25**	**5**	**6.25**	**5.25**
Reduce the need to hire additional employees.	1	1	1	3	1
Reduce the need to purchase additional IT applications.	1	1	1	3	1
Reduce ship's incidents.	5	7	9	9	9
Introduce new ship standards and/or practices.	6	8	9	10	10
Learn & Growth	**4.75**	**5.25**	**2.5**	**4**	**4**
Minimize efforts to carry out risk assessment for a new regulation.	6	8	2	5	5

Minimize efforts to develop plans to implement a new regulation.	5	5	2	5	5
Minimize efforts to provide training regarding implementation of a new regulation.	4	4	2	3	3
Minimize efforts to review the internal business process.	4	4	4	3	3
Operation Department					
Financial	3	3.5	2.25	5	4
Increase in ship's profitability from operational efficiency.	4	8	6	9	9
Reduce operational costs.	2	2	1	4	4
Reduce administration costs.	2	3	1	4	2
Minimize the need for immediate cash to meet regulations requirements.	4	1	1	3	1
Customer	3.5	6	5	7.5	9
Increase ship's operational productivity.	4	9	5	8	8
Increase ship's competitiveness from operation aspect.	4	10	5	8	9
Increase operational quality of ship.	4	3	5	7	9
Reduce errors related to ship's operation.	2	2	5	7	10
Technical Department					
Financial	3	3.5	1.25	4.25	3.75
Increase in ship's profitability from improved technical efficiency.	3	5	2	5	5
Reduce maintenance costs.	2	2	1	5	5
Reduce administration costs.	4	4	1	3	3
Minimize the need for immediate cash to meet regulations requirements.	3	3	1	4	2
Customer	3.25	6.5	4.25	8.5	8.5
Increase ship's technical performance.	4	10	2	7	7
Increase ship's competitiveness from technical aspect.	3	4	5	8	8
Increase technical efficiency of ship.	3	8	5	9	9
Reduce ship errors from technical aspect.	3	4	5	10	10
ISM Department					
Financial	2.75	2.75	3	3.25	2.25
Increase in profitability due to the safe operation of the ship.	3	3	9	4	2

Reduce costs related to maintain safety.	3	3	1	3	3
Reduce administration costs.	3	3	1	3	3
Minimize the need for immediate cash to meet regulations requirements.	2	2	1	3	1
Customer	**3.5**	**3**	**9.5**	**7.75**	**9.75**
Increase ship's performance from safety aspect.	4	2	10	7	10
Increase ship competitiveness from safety aspect.	3	3	9	7	9
Increase ship's safety standards.	4	4	10	9	10
Reduce ship's safety related incidents.	3	3	9	8	10
Learn & Growth	**3**	**3.75**	**5**	**6.25**	**5.25**
Reduce the need to purchase additional IT applications.	1	1	1	4	2
Reduce the need to hire additionally employees	3	3	1	3	1
Reduce ship incidents.	4	5	8	10	10
Introduce new ship standards and/or practices.	4	6	10	8	8
Chartering Department					
Financial	**2.75**	**3.25**	**2.5**	**6.5**	**6.75**
Increase profit from ship hires.	3	5	4	7	9
Increase revenue from ship hires.	3	3	1	8	9
Reduce cost of ship due to a more appropriate execution of charter party.	3	3	4	7	7
Minimize the need for immediate cash to meet regulations requirements.	2	2	1	4	2
Accounting Department					
Financial	**2**	**2**	**2.5**	**6.75**	**7**
Increase overall cash.	2	2	7	6	6
Increase revenues from ships.	2	2	1	8	9
Reduce administration costs.	2	2	1	8	8
Minimize the need for immediate cash to meet regulations requirements.	2	2	1	5	5

7.7 Conclusions

In this chapter, Survey 2 was analysed and its results were presented. As it can be seen in the above sections, a variety of ship operators agree with the outcome of the regulation. Although the significance of the regulation is not in doubt the time consuming procedures, costs and potential errors result in that the ship operators may have a low performance in implementing the given regulation. Therefore, it can be concluded that even small simplified regulations may produce many challenges to a ship operator. These challenges should not be examined as an isolated situation but it should be added to the existing difficulties that are generated by the implementation process of all the previous regulations that a ship operator must follow.

Chapter 8. Discussion

8.1 Introduction

The innovative concern for this research is that the current maritime regulatory environment is not managed on a performance basis. As a result many maritime regulations have become ineffective in large geographic regions. One proposed solution to this issue could be to motivate stakeholders and in particular ship operators to follow an appropriate performance management system. Such a system should produce results relatively fast, accurately and without excessive workload. A common regulatory performance management system for the stakeholders in the shipping industry can help in two aspects, first as an assessment of potential limitations of a regulation, and secondly as a measurement system as to how actually a regulation is implemented and where the stakeholders either fail or face significant challenges.

In this research, it is introduced a performance management for the shipping industry with regard to regulatory implementation. The suggested management system imposes commonly accepted performance indicators for the stakeholders. Thus, it can be used as a tool to assist regulators and stakeholders in implementation of a maritime regulation by evaluating their performance.

8.2 Research Contributions

This research has benefited maritime management science in many significant aspects. The most important contribution is that it deals with a crucial issue of current concern to the shipping industry, which is the worldwide implementation of maritime regulations. The issue was examined from a cost-benefit aspect for each stakeholder. It was found that the burden of some regulations is sometimes excessive certain stakeholders. Additionally it was found that the current regulatory system is very challenging for small stakeholders.

A further contribution of this research is that a methodology and two tools are established in order to evaluate the performance of a stakeholder and in particular that of a ship operator. Hence, it was introduced as an effective management system, which can assist the ship operators and other stakeholders to improve their implementation performance. The proposed management system does not demand an excessive workload or excessive paperwork.

In the proposed methodology practices and methodologies current in many industries and on principles that many developed governments adhere, in order to improve their regulations are examined for their applicability to the shipping industry. Some common principles such as risk analysis, knowledge management and cost evaluation are used in their entirety while the structure of the hierarchies can be modified to satisfy the needs of various stakeholders. The combination of these principles could be used as guidance to each stakeholder to monitor his implementation performance regarding maritime regulations.

The proposed methodology is a unification of methods, which are brought together in an advanced mathematic model. The combination of sound methods such as AHP and the Fuzzy Set Theory produced a decision-making methodology. Regulators can use this methodology as a tool that can justify their decision in introducing a regulation based on accurate and reliable results. This approach is in line with many governments that follow the OECD guidance for improving their regulations and so avoid unnecessary and overlapping regulations.

Furthermore, the outcome of the methodology includes two tools, one for the industry and one for the ship operator. The significance of introducing these tools is that the methodology has been simplified for both the regulators and the industrial stakeholders. Therefore, it can be easily used by stakeholders in the measurement of their implementation performance without the need to carry out the complicated calculations required by AHP and the Fuzzy Set Theory.

In the modern complex shipping industry, mistakes and omissions are often heavily punished. Therefore, a ranking of the priorities that a stakeholder should consider when he implements maritime regulations is of great importance. In this research it was demonstrated how significant is for a stakeholder to use a detailed performance management system when he evaluates his organisation regarding regulatory implementation. However, a system that is limited to the most significant perspectives could be used only for an initial appraisal.

The comparison between the detailed implementation of a tool and selective implementation of the tool reveals two significant points. Firstly, it is very costly for a stakeholder to assess in detail his regulatory performance and keep monitoring. Secondly, a stakeholder may end with misleading conclusions for his regulatory implementation performance if he fails to use a management system or a tool in detail.

An inadequate operation of the proposed tools by a stakeholder could produce a high degree of uncertainty for his organisation's implementation performance. This can be caused because the BSC's elements with small relative weight are numerous. However, these are issues that can expose a stakeholder to risks. It should also be highlighted that they are numerous. This why it is suggested in this research that although the higher ranked elements can show fast an indication of a stakeholder's performance the remaining elements should be examined thoroughly.

8.3 Limitations of Research

A limitation of the proposed methodology is that it is too complicated for the average industrial expert and ship operator although it follows the proven principles that exist in other business sectors. A reason could be that the majority of people working in the industry have specialized experience in certain fields of shipping such as surveying, quality assurance and maintenance. Although these people have high levels of education together with many years of experience, they may have difficulties in understanding practices such as economics and knowledge management.

A further limitation of this research is that the majority of the survey correspondents did not understand the mathematics used in the methodology. The methodology was based on sound methods nevertheless, when it was tested in industry a few challenges were revealed. The first challenge with regard to the mathematics was the lack of understanding by the experts of the linguistic terms that were used. Although many researchers suggested that the linguistic terms represent an easier approach, most of the experts in the shipping industry claim otherwise. They suggested that it would be more preferable to use numerical numbers in a scale of 1 to 10 rather than the linguistic number's scale. A second challenge was the attempt to require the experts to represent their views with nine linguistic terms. This approach led to a great deal of confusion as the meaning of a triangular number was difficult to be understood by people unfamiliar with fuzzy sets. As a consequence one came to the conclusion that the researcher would need to rely on previous acceptable fuzzy set numbers rather than to try to assess their evaluation by a survey correspondent.

8.4 Conclusion

In order to evaluate and improve maritime regulatory performance, this research developed a performance management system and two tools. The industrial tool can be used for a global monitoring of the implementation performance of a maritime regulation by evaluating the stakeholders' performance. Furthermore, the stakeholder's tool may be used by any stakeholder in the shipping industry for detailed evaluation of his performance.

The developed methodology combined the principles of BSC as a modern performance management system with a decision-making technique, AHP. The innovation is that a performance management system should be able to highlight the most significant elements of a management system rather than simply to list them. The methodology and its tools were validated through surveys in order to confirm their applicability in the practical world. Advanced research methods such as Delphi and Fuzzy Set Theory were used in order to compensate for the somewhat limited data available for this research.

Several conclusions were drawn from the work, the most important of which are as follows. First, it confirmed that the states are the most important stakeholders in the shipping industry with regard to the implementation of a maritime regulation, these being followed by classification societies and ship operators. However, the success of a regulation's implementation depends on many other stakeholders. Secondly, the research introduced the concept of a performance management system including costs and benefits analysis as a strategy to improve the current regulatory environment. Thirdly, it confirmed and emphasized the importance of the economic consequences that a regulation may generate. Such costs should be taken into account other aspects such as available knowledge and stakeholders' ability to adapt new procedures.

Chapter 9. Conclusions

9.1 Introduction.

In this chapter the conclusions of this research are presented. These conclusions describe how this research met the initial aim and objectives that were initially stated at Section 1.4. At the end of this chapter some conclusions from the two surveys are presented.

9.2 Evaluation of Main Aim

The main aim of this research was to introduce a methodology regarding performance-based evaluation of a maritime regulation by assessing the costs and benefits of a maritime regulation. The main aim was fulfilled by developing a number of BSCs for the main stakeholder of the shipping industry. These BSCs establish a performance-based structure for the implementation performance of a maritime regulation. The performance of BSCs perspectives and measures is then evaluated by using AHP and Fuzzy Set theory. The sensitivity analysis that was carried out in Chapter 5 demonstrated the rationality of the introduced methodology.

9.3 Evaluation of Main Objectives

At the beginning of this research, five objectives were set in order to fulfil the aim of this research. The first one was to create a system of Balanced Scorecards that includes the commercial activities of every stakeholder. This system was developed in Chapter 4 by identifying perspectives and measures that describe the operational activities of each main stakeholder of the shipping industry. In Survey 1 the correspondent industrial experts justified that the chosen perspectives and measures are valid to evaluate a maritime regulation and they include significant aspects of a cost benefit analysis.

The second objective was to evaluate the degree of contribution of each stakeholder to the regulation implementation by using experts' judgements. The degree of each stakeholder's contribution was determined through his weighting from Survey 1 where the industrial experts compared ten main stakeholders in pairs regarding their contribution to the current regulatory process. The values of the weighting were calculated by using the AHP.

The third objective was to evaluate the experts' judgements by using Fuzzy Set theory. To meet this objective each expert in Survey 1 it was required to provide his judgements by using nine predefined linguistic terms. Additionally, the experts were required to define the triangular fuzzy set of each linguistic term. From this process, a scale of nine fuzzy numbers revealed from Survey 1 and it was used to calculate the weighting of each stakeholder.

The fourth objective was to make pairwise comparisons between the stakeholders in order to rank them according to their weight in the regulation implementation process. Through the Survey 1 experts compared ten main stakeholders in pairs regarding their weighting in the regulatory process. By using AHP those pairwise comparisons were used to determine the weighting of each stakeholder. Then the calculated weights were used in order to rank the stakeholders regarding their significance in the regulatory process.

The final objective was to develop and demonstrate the applicability of the proposed tools through case studies. Two tools were introduced in this research: the industrial tool and the stakeholder's tool. The applicability of both tools was demonstrated in Chapter 5 through case studies. The application of the stakeholder's tool was used in Chapter 7 to evaluate the performance of a ship operator.

9.4 Effectiveness of the Research

The result of this research was to introduce a new strategy of how IMO regulators should assess potential challenges on the implementation of a maritime regulation by adopting a cost benefit methodology. The proposed two stage methodology showed that each stakeholder may be affected in a unique way by the implementation of a new regulation. Furthermore a combination of methodologies that are already used in other industries were applied to the shipping industry, producing a simplified tool for the stakeholders to monitor their regulatory implementation performance as an alternative to sophisticated and bureaucratic management systems.

9.5 Final Conclusions

As described in the above sections a methodology capable of evaluating the implementation performance of a maritime regulation was developed and tested for its applicability in the shipping industry. From the research process and the two surveys carried out the following conclusions were revealed with regard to the maritime regulation implementation process.

An important conclusion from the case studies is that the implementation of a regulation may increase the cost of the stakeholders' commercial activities and make the operation of the shipping industry more complicated. The stakeholders that suffer most of the burdens from a newly introduced maritime regulation will try to postpone its implementation date. Therefore, the regulators should target a fair balance of commercial costs and benefits in order to facilitate the implementation process.

The two-stage approach that was adopted in Chapter 4 showed that it is possible to evaluate the impact of a regulation from multiple aspects. At Stage 1 an initial implementation performance evaluation of a maritime regulation can be carried out for the entire shipping industry. If excessive burdens to some stakeholders are detected at Stage 1 then it is necessary to proceed to Stage 2 where a more detailed analysis can be carried out for the affected stakeholders and their divisions. Therefore, the two-stage approach enables a regulator to assess the imposed burdens of a regulation in detail.

A third conclusion that comes from Survey 1 is that the Balanced Scorecard can be used in the shipping industry as a tool capable of evaluating the implementation costs of a maritime regulation to commercial activities of a stakeholder. The created BSCs of Chapter 4 showed that the BSC is applicable to a variety of stakeholders with different structures and needs. In Survey 2, it was shown how the BSC can be used for assessing the regulatory burdens to a stakeholder and in particular the ship operator by including an analysis of his divisions.

This research introduced the concept of the severity that a maritime regulation may create to some stakeholders and their activities. The weightings of the perspectives as they were calculated in Chapter 6 from Survey 1 indicate that some commercial activities of a stakeholder due to their high weights are of a vital importance for him. Consequently, a maritime regulation may cause a severe impact to a stakeholder if its implementation has a negative effect to these commercial activities.

The fuzzy method was used in Survey 1 due to lack of data. The Fuzzy Set approach was found to be very challenging for industrial experts when they were requested to define a scale of nine linguistic terms with fuzzy triangular numbers. Therefore, in the actual world, a scale of few predefined linguistic terms rather than fuzzy numbers may be used for those unfamiliar with Fuzzy Set theory.

The ranking of stakeholders in Chapter 6 shows the primary role of the states in the implementation of a regulation. On the other hand the significance of the private stakeholders indicates that a maritime regulation can be implemented more easily if they contribute positively. A notable finding is that the crew members have a very low weight in the implementation process although they are the people that will be affected significantly.

In Chapter 6 the divisions of a ship operator were ranked in terms of their importance by using the data from Survey 1. From this ranking a remarkable finding is that the ISM Department is in the third position regarding its importance as a division. This is an indication of how a maritime regulation can change the organization of a ship operator in few years.

Eventually it was shown in Chapter 6 that the industrial experts individually may not be clear about the authority that each stakeholder has in the regulatory process. Some stakeholders such as states have a high regulatory authority by definition. On the other hand, a number of private stakeholders have a commercial power to implement some maritime regulations.

Chapter 10. Future Research

10.1 Future Research

This research set out a framework for evaluating the shipping industry in order to have a better understanding of its operation. However, the size of the industry is too vast in order to conduct a full-scale survey. Therefore, future research should be carried out in order to evaluate other stakeholders in detail. Appropriate exhaustive analyses similar to the one carried for a ship operator in this research should provide valuable information about other stakeholders' organisations. A ranking of other stakeholder priorities and divisions will reveal the limitations of each stakeholder, created by the nature of its commercial activities. For instance, the difference between private companies and public sectors, which operate in the industry, should be explored in more detail.

The proposed stakeholder's tool was tested on ship operators who manage dry bulk carriers. This type of ships was selected in this research because they had suffered a high number of casualties. It is suggested that the tool should be tested on other ship operators who manage other types of ships such as tankers and container vessels. It is expected that other ship operators who manage ships that are more sophisticated may have more difficulties with procedures such as risk analysis for more sophisticated designed ships.

The methodology was based on the practices of other industries and organisations such as nuclear plants, aviation, petrochemical plants and governments. It may be valuable to test if this proposed methodology can be equally applicable in all these industries and organisations. It may be used as a useful tool in more complicated structures of other industries. Furthermore, governments that need fast results for multiple activities may find the approach of a performance management system helpful.

An electronic version of the system would also positively contribute to maximizing the benefits of the system. Most of the ship operators nowadays use IT systems to collect the available information on a daily basis. Software applications can help in automatically collecting the appropriate information such as the number of deficiencies per ship. Such information can then update the values of each measure and therefore a fast conclusion can be automatically available for the ship or division and eventually for the company. The use of such advanced software can be extended to measure the performance of a company's employees according to the targets and criteria set by the company. The mathematics can be avoided by entering linguistic terms.

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Appendix 1 Questionnaire of Survey 1

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Dear Sir/Madam,

The IMO has introduced many conventions, codes, and resolutions collectively known as maritime regulations. These regulations have been promoted as the worldwide uniform regulatory regime encouraging and aiming in the elimination of maritime disasters, accidents and pollution. However, there is some concern being voiced by the IMO with regards to the effective implementation of maritime regulations under this sole unique worldwide umbrella.

A research project at Liverpool John Moores University is currently being carried out with regard to the evaluation of both newly introduced and existing maritime regulations. The necessity for this investigation is the researcher's belief that the existing maritime regulations are not only excessive but that they also generate unnecessary costs. The demands of say the ISM Code on the industry's stakeholders and particularly the ship operators both ashore and afloat, are unwarranted and too expensive. This research will hopefully succeed in its argument that shipping could operate in an equally safe and secure environment if the regulations were to be made more effective and comprehensive.

The primary aim of this research is to evaluate the success of a maritime regulation i.e. what will be the benefits to, and detrimental effects if any, to the stakeholders in fulfilling their obligations. To achieve the aim, the research objectives are:

1. To identify factors that affect the implementation performance of a maritime regulation by the industry
2. To develop and test a tool that will be able to measure the maritime regulation performance of the industry
3. To develop and test a tool that will be able to measure the maritime regulation performance of a stakeholder

Following a thorough review of literature and accident reports, four main aspects, hereafter referred as perspectives, have been identified with regard to the costs and benefits, which a regulation generates for the stakeholders. These perspectives are Financial, Customer, Internal Business and Learn & Growth. Our research now needs to determine sets of measures for these perspectives. A method to identify these measures is required that will provide reliable data. Consequently, a technique has been selected that is based on the gleaning of knowledge from experts of shipping industry. Thus this survey sets out to provide an organized method for collecting views and information pertaining not only to the implementation issues of a maritime regulation but also to the performance of a maritime regulation.

I should be most grateful if I could ask you to spare some of your very valuable time to complete the accompanying questionnaire and to email or post it to myself at the address as shown above. Your vital feedback will greatly benefit and contribute in the formulation of an industry wide opinion. I can assure you that the confidentiality of your response will be honoured and respected.

Yours faithfully,

Hristos Karahalios
Lead Researcher
PgDip., Ch. Officer, Dip.Mar.Sur.

A. Background of Expert (Confidential Information)

1. Name: ____

2. Age:
☐ 18-24 ☐ 25-34 ☐ 35-44 ☐ 45-54 ☐ 55+

3. Position: ____

4. Company Name: ______________________________________

5. Company type:
- ☐ Academic/Research Institute
- ☐ Ship Management
- ☐ Shipowning
- ☐ Classification Society
- ☐ Consultancy
- ☐ Other (please state) ______________________

6. Shipping industry experience not in a managerial position (years):
☐ 0-4 ☐ 5-9 ☐ 10-14 ☐ 15-19 ☐ 20+

7. Managerial experience (years):
☐ 0-4 ☐ 5-9 ☐ 10-14 ☐ 15-19 ☐ 20+

8. Main expertises (You may tick more than one):
- ☐ Safety Management
- ☐ Safety Inspection/Audit/Accident investigation
- ☐ Technical Management
- ☐ Operation Management
- ☐ Accounting Management
- ☐ Other (please state) ______________________

9. Academic qualification achieved:
- ☐ PhD
- ☐ MSc
- ☐ BSc
- ☐ HND
- ☐ High School

10. Professional qualification achieved:
- ☐ Arbitrator
- ☐ Ship surveyor/Auditor
- ☐ Captain/Chief Engineer
- ☐ Chief Officer/2nd Engineer
- ☐ Deck officer/Marine engineer
- ☐ Other (please state) ______________________

11. How important do you think that it is for a company of the shipping industry to be able to measure its performance regarding the implementation of a regulation?
- ☐ Less important
- ☐ Slightly important
- ☐ Important
- ☐ Very important
- ☐ Absolutely important

B. Setting the Measurement Scales.

1. Please provide a range of values that in your opinion evaluate every linguistic term by giving the lower, the upper and the most possible value from 1 to 9.

Linguistic Terms for the Importance	Lower Value	Upper Value	Most Possible Value
Equal Importance (E)			
Equal to Weak Importance (EW)			
Weak Importance (W)			
Weak to Strong Importance (WS)			
Strong Importance (S)			
Strong to Demonstrated Importance (SD)			
Demonstrated Importance (D)			
Demonstrated to Extreme Importance (DEX)			
Extreme Importance (EX)			

2. Please provide a rate range of values from 0 to 10, which you think describes each stage of performance achievement for a company regarding regulation compliance. Please note that the rate ranges should be consecutive.

Achievement	Rate Range
Very High Performance	
High Performance	
Medium Performance	
Low Performance	
Very Low Performance	

C. Relative Importance of the Stakeholders and their Perspectives.

1. In an initial study ten stakeholders as a representative sample of the shipping industry were identified. In your opinion please tick the more important stakeholder of each pairwise comparison in the regulatory implementation process. By using the linguistic terms, as they appear in Question 1 of Section B, please indicate how more important the stakeholder that you chose in each pairwise comparison is.

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Flag State	☐ Coastal State		☐ Coastal State	☐ Classification Society	
☐ Flag State	☐ Classification Society		☐ Coastal State	☐ Ship Operator	
☐ Flag State	☐ Ship Operator		☐ Coastal State	☐ Marine Consultant	
☐ Flag State	☐ Marine consultant		☐ Coastal State	☐ Shipyard	
☐ Flag State	☐ Shipyard		☐ Coastal State	☐ Cargo Owner	
☐ Flag State	☐ Cargo Owner		☐ Coastal State	☐ Underwriter	
☐ Flag State	☐ Underwriter		☐ Coastal State	☐ P&I Club	
☐ Flag State	☐ P&I Club		☐ Coastal State	☐ Crew Members	
☐ Flag State	☐ Crew members		☐ Marine Consultant	☐ Shipyard	
☐ Ship Operator	☐ Marine Consultant		☐ Marine Consultant	☐ Cargo Owner	
☐ Ship Operator	☐ Shipyard		☐ Marine Consultant	☐ Underwriter	
☐ Ship Operator	☐ Cargo Owner		☐ Marine Consultant	☐ P&I Club	
☐ Ship Operator	☐ Underwriter		☐ Marine Consultant	☐ Crew Members	
☐ Ship Operator	☐ P&I Club		☐ Underwriter	☐ P&I Club	
☐ Ship Operator	☐ Crew members		☐ Underwriter	☐ Crew members	
☐ Classification Society	☐ Ship Operator		☐ Shipyard	☐ Cargo Owner	
☐ Classification Society	☐ Marine Consultant		☐ Shipyard	☐ Underwriter	

☐ Classification Society	☐ Shipyard		☐ Shipyard	☐ P&I Club	
☐ Classification Society	☐ Cargo Owner		☐ Shipyard	☐ Crew Members	
☐ Classification Society	☐ Underwriter		☐ Cargo Owner	☐ Underwriter	
☐ Classification Society	☐ P&I Club		☐ Cargo Owner	☐ P&I Club	
☐ Classification Society	☐ Crew Members		☐ Cargo Owner	☐ Crew Members	
☐ P&I Club	☐ Crew Members				

2. In the same study four perspectives regarding regulation performance were identified for each stakeholder of the shipping industry. In your opinion please tick the more important perspective of every pairwise comparison for the stakeholder. By using the linguistic terms, as they appear in Question 1 of Section B, please indicate how more important a perspective from each pairwise comparison is.

2.1 Flag State

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.2 Coastal State

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.3 P&I Club

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.4 Classification Society

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.5 Ship Operator

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.6 Underwriter					
Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.7 Marine Consultant					
Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.8 Shipyard					
Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.9 Cargo Owner					
Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.10 Crew Members					
Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

D. Rating the Importance of the Stakeholders' Measures.

1. Each identified perspective is described and defined by four measures. Please tick the importance rate of each measure by using values from 1 to 5.

(1) Not Important	(2) Little Important	(3) Average	(4) Important	(5) Very Important

1.1 Flag State						
Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase revenues from new registered ships.					
	Increase revenues from existing registered fleet.					
	Keep administration costs to low level.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase the operation efficiency of its fleet.					

	Create more competitive fleet.					
	Increase the quality standards of its fleet.					
	Improve fleet records.					
Learning and Growth	Reduce the need to hire additionally employees.					
	Reduce the need to purchase additionally IT applications.					
	Reduce the number of its fleet incidents.					
	Introduce new ship standards.					
Internal Business	Minimize efforts to carry out risk assessment for a regulation.					
	Minimize efforts to develop plans to implement a regulation.					
	Minimize efforts to provide training regarding implementation of a regulation.					
	Minimize efforts to review the internal business process.					

1.2 Coastal State

Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase revenues from new port facilities.					
	Increase revenue from commercial ports.					
	Minimize costs of facilities, administration and services.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase productivity of ports.					
	Increase ports competitiveness.					
	Increase the quality standards of its ports.					
	Improve safety standards regionally.					
Learning and Growth	Reduce the need to hire additionally employees.					
	Reduce the need to purchase additionally IT applications.					
	Reduce damages to natural resources.					
	Introduce new port standards.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.3 Classification Society

Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase revenues from new services.					
	Increase revenue from existing ships of its class.					
	Minimize costs of facilities, administration and services.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Acquire more contracts with ship operators.					
	Increase class competitiveness.					
	Increase the quality standards of its ports.					
	Improve ships accidents records					
Learning and Growth	Reduce the need to hire additionally employees.					
	Reduce the need to purchase additionally IT applications.					
	Reduce the number of its fleet incidents.					
	Introduce new ship standards.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.4 P&I Club						
Perspective	**Measure**	**Rate**				
		1	2	3	4	5
Financial	Increase revenues from new risks insured.					
	Reduce amounts paid for claims.					
	Reduce administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Acquire more insurance contracts.					
	Increase competitiveness.					
	Improve the quality of services.					
	Improve accidents records.					
Learning and Growth	Reduce the need to hire additionally employees.					
	Reduce the need to purchase additionally IT applications.					
	Reduce the number of claims.					
	Introduce new ship operation standards.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.5 Underwriter						
Perspective	**Measure**	**Rate**				
		1	2	3	4	5
Financial	Increase revenues from new risks insured.					
	Reduce amounts paid for claims.					
	Reduce administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Acquire more insurance contracts.					
	Increase competitiveness.					
	Improve the quality of services.					
	Improve accidents records.					
Learning and Growth	Reduce the need to hire additionally employees.					
	Reduce the need to purchase additionally IT applications.					
	Reduce the number of claims.					
	Introduce new ship operation standards.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.6 Shipyard						
Perspective	**Measure**	**Rate**				
		1	2	3	4	5
Financial	Increase revenue from new building ships orders.					
	Increase revenue from ships mandatory repairs.					
	Reduce administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase the number of building ships and repairs.					
	Increase competitiveness.					
	Increase quality shipyards standards.					
	Improve ships design.					
Learning and Growth	Reduce the need to hire additionally employees.					
	Reduce the need to purchase additionally IT applications.					

	Reduce the number of its claims.					
	Introduce new ship design standards.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.7 Cargo Owner

Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase revenues due to faster transport of cargoes.					
	Increase revenue from safer transport of cargoes.					
	Minimize losses due to accidents.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase market share.					
	Increase reputation and credibility.					
	Increase quality of cargoes.					
	Reduce the number of accidents caused by cargoes.					
Learning and Growth	Reduce the need to hire additionally employees.					
	Reduce the need to purchase additionally IT applications.					
	Reduce the number of cargo losses.					
	Introduce new cargo transport standards.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.8 Marine Consultant

Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase revenues by providing new consultancy services.					
	Increase revenues from existing consultancy services.					
	Minimize administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase the number of services.					
	Increase reputation and credibility.					
	Improve the quality of services.					
	Reduce the number of failures.					
Learning and Growth	Reduce the need to hire additionally employees.					
	Reduce the need to purchase additionally IT applications.					
	Reduce the number of its claims.					
	Introduce new ship standards.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.9 Ship Operator

Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase profit.					
	Decrease capital cost.					
	Reduce administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					

Customer	Increase contracts with cargo owners.					
	Increase reputation and credibility.					
	Improve the quality of services.					
	Reduce the number of claims.					
Learning and Growth	Reduce the need to hire additionally employees.					
	Reduce the need to purchase additionally IT applications.					
	Reduce fleet incidents.					
	Introduce new ship standards.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					
1.10 Crew Members						
Perspective	**Measure**	**Rate**				
		1	**2**	**3**	**4**	**5**
Financial	Increase income by additional payments.					
	Demand for larger the number of crew required onboard.					
	Reduce time for training.					
	Reduce training expenses.					
Customer	Increase ship operators' satisfaction.					
	Increase availability of skill full crewmembers.					
	Increase the quality of crewmembers.					
	Increase reputation and credibility.					
Learning and Growth	Improve their knowledge.					
	Improve their IT skills.					
	Reduce accidents from human error.					
	Introduce new ship standards & practices.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

E. Relative Importance of a Ship Operator's Divisions and their Perspectives.

1. For more detailed analysis of the factors that affect a stakeholder in the implementation process the study was extended to one stakeholder who was chosen to be a ship operator. It was selected a model of a ship operator, which consists of ten divisions and operates one ship. In your opinion please the more important division for a ship operator. By using the linguistic terms, as they appear in Question 1 of Section B, please indicate how more important the division that you chose in each pairwise comparison is.

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Managing Director	☐ Operation Department		☐ Operation Department	☐ Technical Department	
☐ Managing Director	☐ Technical Department		☐ Operation Department	☐ ISM Department	
☐ Managing Director	☐ ISM Department		☐ Operation Department	☐ Chartering Department	
☐ Managing Director	☐ Chartering Department		☐ Operation Department	☐ Accounting Department	
☐ Managing Director	☐ Accounting Department		☐ Operation Department	☐ Crew Department	

☐ Managing Director	☐ Crew Department		☐ Operation Department	☐ ISPS Department	
☐ Managing Director	☐ ISPS Department		☐ Operation Department	☐ Supply Department	
☐ Managing Director	☐ Supply Department		☐ Operation Department	☐ Ship	
☐ Managing Director	☐ Ship		☐ Chartering Department	☐ Accounting Department	
☐ ISM Department	☐ Chartering Department		☐ Chartering Department	☐ Crew Department	
☐ ISM Department	☐ Accounting Department		☐ Chartering Department	☐ ISPS Department	
☐ ISM Department	☐ Crew Department		☐ Chartering Department	☐ Supply Department	
☐ ISM Department	☐ ISPS Department		☐ Chartering Department	☐ Ship	
☐ ISM Department	☐ Supply Department		☐ ISPS Department	☐ Supply Department	
☐ ISM Department	☐ Ship		☐ ISPS Department	☐ Ship	
☐ Technical Department	☐ ISM Department		☐ Accounting Department	☐ Crew Department	
☐ Technical Department	☐ Chartering Department		☐ Accounting Department	☐ ISPS Department	
☐ Technical Department	☐ Accounting Department		☐ Accounting Department	☐ Supply Department	
☐ Technical Department	☐ Crew Department		☐ Accounting Department	☐ Ship	
☐ Technical Department	☐ ISPS Department		☐ Crew Department	☐ ISPS Department	
☐ Technical Department	☐ Supply Department		☐ Crew Department	☐ Supply Department	
☐ Technical Department	☐ Ship		☐ Crew Department	☐ Ship	
☐ Supply Department	☐ Ship				

2. The four perspectives regarding regulation performance were identified for each department of the ship operator. In your opinion please tick the more important perspective for every department. By using the linguistic terms, as they appear in Question 1 of Section B, please indicate how more important the department that you chose in each pairwise comparison is.

2.1 Managing Director					
Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.2 Operation Department					
Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.3 Technical Department

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.4 ISM Department

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.5 Chartering Department

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.6 Accounting Department

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.7 Crew Department

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.8 ISPS Department

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.9 Supply Department

Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

2.10 Ship					
Pairwise Comparison		Importance	Pairwise Comparison		Importance
☐ Financial Perspective	☐ Customer Perspective		☐ Customer Perspective	☐ Internal Business Perspective	
☐ Financial Perspective	☐ Internal Business Perspective		☐ Customer Perspective	☐ Learning & Growth Perspective	
☐ Financial Perspective	☐ Learning & Growth Perspective		☐ Internal Business Perspective	☐ Learning & Growth Perspective	

G. Rating the Importance of the Divisions' Measures.

1. Each identified perspective is described and defined by four measures. Please tick the rate importance of each measure by using values from 1 to 5.

(1) Not Important	(2) Little Important	(3) Average	(4) Important	(5) Very Important

1.1 Managing Director						
Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase profit.					
	Decrease capital cost.					
	Reduce administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Reduce off hire days.					
	Increase reputation and credibility.					
	Improve the quality of ship's activities.					
	Reduce the number of claims.					
Learning and Growth	Reduce the need to hire additionally employees.					
	Reduce the need to purchase additionally IT applications.					
	Reduce ship's incidents.					
	Introduce new ship standards and/or practices.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.2 Operation Department						
Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase ship's profit from operational efficiency.					
	Reduce operational costs.					
	Reduce administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase ship's operational productivity.					
	Increase ship's competitiveness from operation aspect.					
	Increase operational quality of ship.					
	Reduce errors related to ship's operation.					
Learning and Growth	Reduce the need to hire additionally employees in the operation department.					
	Reduce the need to purchase additionally IT applications.					
	Reduce ship incidents.					
	Introduce new ship standards and/or practices.					
Internal	Minimize efforts to carry out risk assessment for a new regulation.					

Business	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.3 Technical Department

Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase ship's profit from technical efficiency.					
	Reduce maintenance costs.					
	Reduce administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase ship's technical performance.					
	Increase ship's competitiveness from technical aspect.					
	Increase technical efficiency of ship.					
	Reduce ship errors from technical aspect.					
Learning and Growth	Reduce the need to hire additionally employees in the technical department.					
	Reduce the need to purchase additionally IT applications.					
	Reduce ship incidents.					
	Introduce new ship standards and/or practices.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.4 ISM Department

Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase profit by the safe operation of the ship.					
	Reduce costs related to maintain safety.					
	Reduce administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase ship's performance from safety aspect.					
	Increase ship competitiveness from safety aspect.					
	Increase ship's safety standards.					
	Reduce ship's safety incidents.					
Learning and Growth	Reduce the need to hire additionally employees in the ISM department.					
	Reduce the need to purchase additionally IT applications.					
	Reduce ship incidents.					
	Introduce new ship standards and/or practices.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.5 Chartering Department

Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase profit from ship hires.					
	Increase revenue from ship hires.					
	Reduce costs of ship due to inappropriate execution of charter.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase ship's high performance.					
	Increase ship's competitiveness from commercial aspect.					
	Increase ship's quality standards.					

		1	2	3	4	5
	Reduce ship commercial errors.					
Learning and Growth	Reduce the need to hire additionally employees in the chartering department.					
	Reduce the need to purchase additionally IT applications.					
	Reduce ship incidents.					
	Introduce new ship standards and/or practices.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.6 Accounting Department

Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase overall cash flow.					
	Increase revenues from ships.					
	Reduce administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Improve company's wealth.					
	Reduce ship's expenses.					
	Increase ships quality standards ship from economic aspect.					
	Decrease company's financial disorders.					
Learning and Growth	Reduce the need to hire additionally employees in the accounting department.					
	Reduce the need to purchase additionally IT applications.					
	Reduce ship incidents.					
	Introduce new ship standards and/or practices.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.7 Crew Department

Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase profit by hiring high quality crew.					
	Increase revenue by effective crew performance.					
	Reduce crew costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase crew efficiency.					
	Increase ship's competitive from crew aspect.					
	Increase the quality of crew.					
	Reduce errors from crew.					
Learning and Growth	Reduce the need to hire additionally employees in the Crew Dept.					
	Reduce the need to purchase additionally IT applications.					
	Reduce ship incidents.					
	Introduce new ship standards and/or practices.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.8 ISPS Department

Perspective	Measure	Rate				
		1	2	3	4	5
Financial	Increase profit by the secure operation of the ship.					

	Reduce costs related to security.					
	Reduce administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase ship's performance from security aspect.					
	Increase ship's competitiveness from security aspect.					
	Increase ship's security standards.					
	Reduce ship's security incidents.					
Learning and Growth	Reduce the need to hire additionally employees in the ISPS Dept.					
	Reduce the need to purchase additionally IT applications.					
	Reduce ship incidents.					
	Introduce new ship standards and/or practices.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.9 Supply Department

Perspective	**Measure**	**Rate**				
		1	**2**	**3**	**4**	**5**
Financial	Reduce spare parts requisitions.					
	Increase revenue by the good operation of the ship.					
	Reduce administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase ship's spares efficiency.					
	Increase ship's competitiveness from supply aspect.					
	Increase supply quality of ship.					
	Reduce ship errors from supply aspect.					
Learning and Growth	Reduce the need to hire additionally employees in the Supply Dept.					
	Reduce the need to purchase additionally IT applications.					
	Reduce ship incidents.					
	Introduce new ship standards and/or practices.					
Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

1.10 Ship

Perspective	**Measure**	**Rate**				
		1	**2**	**3**	**4**	**5**
Financial	Increase ship's profit.					
	Reduce ship costs.					
	Reduce ship administration costs.					
	Minimize the need for immediate cash to meet regulations requirements.					
Customer	Increase ship's productivity.					
	Increase ship's competitiveness.					
	Increase ship standards.					
	Reduce human errors onboard.					
Learning and Growth	Reduce the need to hire additionally crew.					
	Reduce the need to purchase additionally IT applications.					
	Reduce ship incidents.					
	Introduce new ship standards and/or practices.					

Internal Business	Minimize efforts to carry out risk assessment for a new regulation.					
	Minimize efforts to develop plans to implement a new regulation.					
	Minimize efforts to provide training regarding implementation of a new regulation.					
	Minimize efforts to review the internal business process.					

H. Comments.

If you have any general comments on regulation performance evaluation or with regard to this questionnaire, please feel free to suggest in the space below.

Appendix 2 Questionnaire of Survey 2

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JMU
Liverpool John Moores University

Dear Sir/Madam,

The IMO has introduced many conventions, codes, resolutions and circulars collectively known as "Maritime Regulations". These regulations have been promoted as the worldwide uniform regulatory regime encouraging and aiming at the reduction or elimination of maritime disasters, accidents and pollution. However, there is some concern that the implementation of every maritime regulation may create difficulties and costs for a ship operator.

A research project at Liverpool John Moores University is currently being carried out with regard to the evaluation of both newly introduced and existing maritime regulations. This research will hopefully succeed in highlighting potential difficulties that ship operators face with maritime regulations. Following a thorough review of literature and accident reports, six main Divisions representing a structure of a typical bulk carrier company have been identified with regard to the costs and benefits, which a regulation generates for a ship operator. These six Divisions are Managing Director, Operation Department, Technical Department, ISM Department, Chartering Department and Finance/Accounting Department. Furthermore a set of measures has been identified in order to evaluate the performance of each Division.

Our research now needs to determine the effect of a maritime regulation implementation on each of these Divisions and their measures. Thus this survey sets out to provide an organized method for collecting views and information pertaining not only to the implementation issues of a maritime regulation, but also to the performance of a maritime regulation.

I should be most grateful if I could ask you to spare some of your very valuable time to complete the accompanying questionnaire, and then to e-mail or post it to myself at the address as shown above. Your vital feedback will greatly benefit and contribute in the formulation of an industry wide opinion. I can assure you that the confidentiality of your response will be honoured and respected.

Yours sincerely,

Hristos Karahalios
Doctoral Researcher
PgDip., Ch. Officer, Dip.Mar.Sur.
Lecturer in the Maritime Centre in School of Engineering, Liverpool John Moores University

A. Instructions

1. For the purpose of this survey a bulk carrier company structure was designed to include six main Divisions each one representing some of the company's activities. These Divisions are:

Division	Activities
1. Managing Director	Overall management, hiring employees, ships purchase and scrapping.
2. Operation Department	Operation and performance of a ship in accordance to its commercial and legal obligations.
3. Technical Department	Operation, performance and maintenance of the engineering and technical systems of a ship (structure, cargo systems, navigation machinery), dry-docking and repairs.
4. ISM Department	Safety management, implementation of safety and pollution regulations
5. Chartering Department	Chartering and charter compliance.
6. Finance/Accounting Department	Budgetary control.

3. Under each Division there is a set of measures indicating its performance. Each measure is written in such a way in order to indicate its desirable goal as in the examples below:

Measures	Measurement Quantity	Performance Achievement
Increase income.		
Decrease capital cost.		

5. The measurement quantity indicates the quantity that should be evaluated for each measure in order to achieve the goal as in the example below:

Measures	Measurement Quantity	Performance Achievement
Increase income.	Amount of money from days on-hire	
Decrease capital cost.	Amount of money	

6. Eventually each measure should be evaluated in a rate from 0 to 10 in the Performance Achievement column. A high rate should indicate a high achievement of the measure. For instance in the example below the income of the company has increased significantly due to the implementation of a specific regulation because the amount of money from on hire days was increased. This indicates a high performance and therefore the evaluation of Performance Achievement will be 8 by reference to Table 1.

1.1 Managing Director		
Measures	**Measurement Quantity**	**Performance Achievement**
Increase income.	Amount of money from on hire days	8

Table 1. Performance Rates

Performance Achievement	Rating Range
Very High	9-10
High	7-8
Medium	5-6
Low	3-4
Very Low	0-2

B. Background of Company (Confidential Information)

1. Company Name: ____________________

2. Number of company's personnel ashore: ____________________

3. Number of ships operated by the company: ____________________

C. Background of Correspondent (Confidential Information)

1. Name: ____________________

2. Age:
☐ 18-24 ☐ 25-34 ☐ 35-44 ☐ 45-54 ☐ 55+

3. Sex:
☐ Male ☐ Female

4. Position: ____________________

5. Main expertises (You may tick more than one):
☐ Safety Management
☐ Safety Inspection/Audit/Accident investigation
☐ Technical Management
☐ Operation Management
☐ Finance/Accounting Management
☐ Other (please state) ____________________

6. Academic qualification achieved:
☐ PhD
☐ MSc
☐ BSc
☐ HND
☐ High School
☐ Other (please state) ____________________

7. Professional qualification achieved (You may tick more than one):
☐ Arbitrator
☐ Ship surveyor/Auditor
☐ Captain/Chief Engineer
☐ Chief Officer/2nd Engineer
☐ Deck officer/Marine engineer
☐ Other (please state) ____________________

8. How important do you think that it is for a company of the shipping industry to be able to measure its performance regarding the implementation of a regulation?
☐ Less important
☐ Slightly important
☐ Important
☐ Very important
☐ Absolutely important

D. Main Questionnaire

1. The SOLAS regulation II-1/19.1, as amended by resolution MSC.216(82), states:

"Damage control information

There shall be permanently exhibited, or readily available on the navigation bridge, for the guidance of the officer in charge of the ship, plans showing clearly for each deck and hold the boundaries of the watertight compartments, the openings therein with the means of closure and position of any controls thereof, and the arrangements for the correction of any list due to flooding. In addition, booklets containing the aforementioned information shall be made available to the officers of the ship."

Please provide a rate from 0 to 10, by reference to Table 2, indicating what performance you think that your company could achieve for each measure in complying with the above mentioned regulation.

Table 2. Performance Rates

Performance Achievement	Rating Range
Very High	9-10
High	7-8
Medium	5-6
Low	3-4
Very Low	0-2

1.1 Managing Director

Measures	Measurement Quantity	Performance Achievement
Increase income.	Amount of money from on hire days	
Decrease capital cost.	Amount of money	
Reduce administration costs.	Amount of money	
Minimize the need for immediate cash to meet regulations requirements.	Amount of money	
Reduce off hire days.	Number of off hire days	
Increase reputation and credibility.	Number of claims	
Improve quality of ship's activities.	Number of managerial deficiencies (e.g. unsafe methods and procedures, inadequate supervision, communications breakdown etc)	
Reduce the number of claims.	Number of accidents	
Reduce the need to hire additional employees.	Number of additional vacancies	
Reduce the need to purchase additional IT applications.	Number of new IT applications	
Reduce ship's incidents.	Number of human errors.	
Introduce new ship standards and/or practices.	Number of new standards and practices	
Minimize efforts to carry out risk assessment for a new regulation.	Money/hours spent	

Minimize efforts to develop plans to implement a new regulation.	Money/hours spent	
Minimize efforts to provide training regarding implementation of a new regulation.	Money/hours spent	
Minimize efforts to review the internal business process.	Money/hours spent	

1.2 Operation Department

Measures	Measurement Quantity	Performance Achievement
Increase in ship's profitability from operational efficiency.	Amount of money (off hire days, penalties etc)	
Reduce operational costs.	Amount of money	
Reduce administration costs.	Amount of money	
Minimize the need for immediate cash to meet regulations requirements.	Amount of money	
Increase ship's operational productivity.	Number of errors that caused cost	
Increase ship's competitiveness from operation aspect.	Number of claims	
Increase operational quality of ship.	Number of managerial deficiencies (e.g. unsafe methods and procedures, inadequate supervision, communications breakdown etc)	
Reduce errors related to ship's operation.	Number of accidents	

1.3 Technical Department

Measures	Measurement Quantity	Performance Achievement
Increase in ship's profitability from improved technical efficiency.	Amount of money (off hire days, penalties etc)	
Reduce maintenance costs.	Amount of money	
Reduce administration costs.	Amount of money	
Minimize the need for immediate cash to meet regulations requirements.	Amount of money	
Increase ship's technical performance.	Number of errors that caused cost	
Increase ship's competitiveness from technical aspect.	Number of claims	
Increase technical efficiency of ship.	Number of managerial deficiencies (e.g. unsafe methods and procedures, inadequate supervision, communications breakdown etc)	
Reduce ship errors from technical aspect.	Number of accidents	

1.4 ISM Department

Measures	Measurement Quantity	Performance Achievement
Increase in profitability due to the safe operation of the ship.	Amount of money (off hire days, penalties etc)	
Reduce costs related to maintain safety.	Amount of money	

Reduce administration costs.	Amount of money	
Minimize the need for immediate cash to meet regulations requirements.	Amount of money	
Increase ship's performance from safety aspect.	Number of errors that caused cost	
Increase ship competitiveness from safety aspect.	Number of claims	
Increase ship's safety standards.	Number of managerial deficiencies (e.g. unsafe methods and procedures, inadequate supervision, communications breakdown etc)	
Reduce ship's safety related incidents.	Number of accidents	
Reduce the need to hire additional employees in the ISM department.	Number of additional vacancies	
Reduce the need to purchase additional IT applications.	Number of new IT applications	
Reduce ship incidents.	Number of human errors	
Introduce new ship standards and/or practices.	Number of new standards and practices	
Minimize efforts to review the internal business process.	Money/hours spent	

1.5 Chartering Department

Measures	Measurement Quantity	Performance Achievement
Increase profit from ship hires.	Amount of money (off hire days, penalties etc)	
Increase revenue from ship hires.	Amount of money	
Reduce cost of ship due to a more appropriate execution of charter party.	Amount of money	
Minimize the need for immediate cash to meet regulations requirements.	Amount of money	

1.6 Finance/Accounting Department

Measures	Measurement Quantity	Performance Achievement
Increase overall cash.	Amount of money (off hire days, penalties etc)	
Increase revenues from ships.	Amount of money	
Reduce administration costs.	Amount of money	
Minimize the need for immediate cash to meet regulations requirements.	Amount of money	

E. Comments

If you have any general comments on regulation performance evaluation or with regard to this questionnaire, please feel free to suggest in the space below.