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## Executive summary

The Flagship A1 sub-project has developed a number of scenarios for future shipping operations and one of the clear trends is the demand for more efficient cooperation between the different parties in the business. This is a non-trivial issue due to the well established business practices and corresponding legal framework. The role of Key Performance Indicators (KPIs) and performance based contracts were among the issues discussed and which were expected to make a difference in the near future. Concurrently with the Flagship project, MARINTEK has been the R&D partner in the shipping KPI project<sup>1</sup> where a number of management companies cooperated to develop common and standardized Key Performance Indicators (KPIs) for the management of ships.

This led to the idea of testing out the concept of performance based contracts (PbC) in ship management. As expected, this is not trivial and the demonstration of the concept presented in this report has probably not found the one and correct answer. However, this report describes how the concept can be implemented in practical terms by using data from the Shipping KPI project in a real life scenario. The report will also discuss necessary changes to the contractual framework – here exemplified by the standard SHIPMAN contract from BIMCO.

The PbC concept tested in this reports is based on using the budget performance indicator as basis for calculation penalty or profit and using a number of other KPI performance indicators to verify that any profit is not gained on underperformance on other aspects of the management operation. By using data from the Shipping KPI database, it is shown how this would work in a number of cases.

The relationship between ship manager and owner is not the area where most money is involved. Management fees and budgets represent just a few percentages of the total operating cost of the ship. One may rightly argue that a performance based contract between owner and manager is of limited interest from this perspective. However, there are also important arguments why this exercise is necessary:

1. This report describes a demonstration of a general concept that can be used also in other relationships, e.g., between charterer and owner. The reason why the management relationship has been chosen is that data on management performance was available through the Shipping KPI database.
2. If one wants to reduce ship greenhouse gas emissions through operational measures, one needs to involve all parties – including management – and provide incentives for optimal operations, e.g., through performance based contracts.

The overall conclusion is that the concept is very promising, but that more research is needed to better quantify the benefits for the owner and the manager. The general idea behind a performance based contract is that risks and profits are more equally shared between the partners and this requires that the dynamics of these parameters are well understood as well as having good and transparent mechanisms for measuring the performance.

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<sup>1</sup> See <http://www.shipping-kpi.com>

Performance based contracts will likely be an important component in the aim of reducing greenhouse gas emissions from shipping through operational measures. The IMO GHG study (2009) indicates that up to a 50% reduction is possible through such measures, including slow steaming, but this can only be achieved by introducing new incentives in the relationships between the parties that can influence on energy use onboard.

# Table of Contents

List of Abbreviations .....	8
1 Introduction .....	9
1.1 Acknowledgement .....	10
2 The structure of shipping.....	11
2.1 Shipping Description .....	11
2.1.1 Administration (Financial management) .....	11
2.1.2 Commercial management.....	11
2.1.3 Ship Management.....	13
2.2 Outsourcing.....	15
2.2.1 Introduction .....	15
2.2.2 Background 3rd party Technical Ship Management.....	16
2.2.3 KPIs and 3rd party Technical Ship Management .....	18
3 Performance-based Contracting.....	20
3.1 Introduction .....	20
3.2 Contracts.....	21
3.2.1 Definition.....	21
3.2.2 Types of Contract .....	21
3.3 Understanding PbC .....	23
3.3.1 The concept of PbC .....	23
3.3.2 Origin - A US-born concept? .....	25
3.3.3 Pros and Cons.....	26
3.4 Theoretical foundation of PbC.....	27
3.4.1 Agency theory .....	27
3.4.2 Transaction Cost Economics (TCE) .....	28
3.4.3 Related concepts and principles .....	29
3.5 PbC in practice .....	31
3.5.1 Defense, Aerospace .....	32
3.5.2 Insurance.....	32
3.5.3 Labor economics .....	32
3.5.4 Managerial incentives.....	32
3.5.5 Public service outsourcing / Social Service .....	33
3.5.6 Call-centers and referrals.....	33
3.5.7 Public service outsourcing / Transport .....	33

3.5.8	Supply Chain Contracts, 3PL, B2B .....	34
3.5.9	Maintenance, Repair and Operation (MRO) service outsourcing.....	34
3.5.10	R&D outsourcing .....	35
3.5.11	Software Development Outsourcing .....	35
3.5.12	Outsourcing of Marketing services .....	35
3.5.13	Computer network service – SLA.....	36
3.5.14	Professional Services.....	36
4	PbC for Ship Management .....	37
4.1	Introduction to PBC and Technical Ship Management .....	37
4.2	Performance for whom, by whom? .....	37
4.2.1	Managerial Contract .....	38
4.2.2	Outsourcing Contract.....	38
4.2.3	Single-goal Contract .....	38
4.3	Conceptual application of PbC for Ship management .....	38
4.4	Learning points from other sectors and types of relationships.....	44
4.5	PbC for Ship Management – Pros & Cons.....	48
5	Mapping of Shipping KPIs to Performance Based Contracts in Ship Management.....	50
5.1	Shipping KPIs not suited for performance based contracting in their original form.....	50
5.2	Mapping between Shipping KPIs and SHIPMAN .....	51
5.3	Mapping between Shipping KPIs and generic processes defined in Flagship.....	52
5.3.1	Provide Crew .....	53
5.3.2	Run Ship .....	54
5.3.3	Maintain or repair ship .....	55
5.4	Mapping between Shipping KPIs and Ship owners’ areas of interest .....	56
5.5	Shipping KPIs relevant for the Flagship demonstrator concerning Performance Based Contracting.....	57
6	Process for Performance Based Contracts in ship management.....	60
6.1	Creation of a Performance Based Contract .....	60
6.1.1	Definition of the bonus/penalty regime .....	61
6.1.2	Selection of KPIs.....	65
6.1.3	Definition of KPI Target Values and bonus/penalty.....	70
6.2	Auditing in a PbC setting.....	72
6.2.1	How this was done for the demonstrator.....	73
6.3	Valuation of results .....	73

6.3.1	How this was done for the demonstrator.....	74
7	From manager/owner to integrated operations in shipping.....	77
7.1	Ship management has an important impact on the operation .....	77
7.2	The example can be generalized.....	77
7.3	All parties need to pull together .....	78
8	Conclusions .....	79
9	References .....	80

## List of Abbreviations

ETA	Estimated Time of Arrival
BPR	Business Processes Reengineering
BIMCO	Baltic International Maritime Council
CAPEX	Capital expenses
COA	Contract of Affreightment
CPAF	Cost-Plus-Award-Fee
CPC	Cost-Plus Contract
CPIC	Cost-Plus Incentive Contract
CPIF	Cost-Plus-Incentive-Fee
CPFF	Cost-Plus-Fixed-Fee
CPPC	Cost-Plus-Percentage of Cost
CSR	Corporate Social Responsibility
FFC	Fixed Fee Contract
FFP	Fixed Fee Price
FP	Fixed-Price
FPI	Fixed-price-plus-Incentive Fee
FPIC	Fixed price incentive contract
IMO	International Maritime Organization
ISM	International Safety Management
ITF	International Transport Workers Federation
KPI	Key Performance Indicators
LTIF	Lost Time Injury Frequency
LTSF	Lost Time Sickness Frequency
MRO	Maintenance, Repair and Operation
OLA	Operation Level Agreement
OPEX	Operational expenses
PbC	Performance-based Contract or Performance-based Contracting.
PBI	Performance Based Indicators
PSC	Port State Control
PI	Performance Indicators
PMS	Planned Maintenance Systems
QoS	Quality of Service
TCE	Transaction Cost Economics.
T&M	Time and Material
SLA	Service Level Agreement.
SOLAS	International Convention for the Safety Of Life At Sea
VPIC	Variable Price Incentive Contract

# 1 Introduction

Subproject A1 (Technical operation strategy and logistics) in Flagship has developed specifications for how ship operations currently function and suggestions as to how it could be improved. One element that surfaced was the need to improve cooperation between parties in the shipping industry. A major problem identified was how this could be achieved in a business with century long traditions and established cooperation patterns and contract forms. This report discusses how to use operational KPIs to improve cooperation between parties in the maritime domain, particularly in the area of contractual performance.

Based on results from other parts of the Flagship project it was decided to develop a demonstration scenario for performance based contracts between ship owner and manager. The problems addressed are the selection of suitable performance indicators, to develop contracts that can use such indicators and to establish mechanisms by which the parties can trust the indicators.

To make an effective demonstration of this concept, Flagship has teamed up with the industry initiative “Shipping KPI”<sup>2</sup>. The Shipping KPI project has developed a set of standard KPIs for performance measurement in the ship management business. The purpose was mainly to be able to publish these KPIs and by that quantify the actual performance of the ship management companies. The standardized KPIs would also allow the companies to compare their performance against an industry benchmark and by that be able to measure and improve their performance. After the KPI standard was developed in its first version, the project has been collecting management related data over a two year period.

The Shipping KPI database has been used in simulations to examine the concept developed through this demonstration. This has enabled us to examine realistic scenarios without the tremendous effort of going through a full data collection exercise. About 400 ships are registered in the database and this makes it very suited for simulations of how management based contracts would work in real life. Ship types and contract forms have been selected to allow us to keep the ships and management companies anonymous.

The demonstration has been focusing on what KPIs to use and how the use of KPIs can be built into a standard contract between ship owner and manager. The contract used has been the SHIPMAN contract from BIMCO. The purpose of the demonstration is to test the assumption that performance based contracts can give real and quantifiable benefits.

The remaining parts of this document describe the demonstration and its context in a number of sections:

- The general aspects of the ship management business. This is in a sense the constraints the performance based contracts must operate under (section 2). This may be known material for many, but is included for readers not familiar with the shipping business.

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<sup>2</sup> <http://www.shipping-kpi.com>

- A general overview of the theory behind performance based contracting. This defines what can be achieved and what cannot be done through this type of relationship (section 3). Again, this may be familiar material, but is included for completeness.
- A theoretical synthesis of ship management constraints and performance based contracts. This discusses the possibilities and constraints inherent in the concept (section 4).
- An analysis of how the Shipping KPI indicators can be used in performance based contracting. This section looks at the strengths and the weakness of the indicators in light of the previous sections' conclusions (section 5).
- A walkthrough of the actual demonstrator which also discusses how the overall processes needs to be adapted to this type of contract. This includes the steps from the creation of the contract to the calculation of bonus or penalty for the partners (section 6).
- Section 7 discusses how the developed concept can be extended.
- Section 8 summarizes the experience gained; and
- Section 9 contains references.

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## **2 The structure of shipping**

### **2.1 Shipping Description**

A shipping company may be operated and organized in several ways. One of the main choices to be made is whether or not to run the company fully integrated or to outsource one or several departments to third party companies. A shipping company may be viewed as a composition of three basic divisions; technical management, commercial management and administration (financial management). The outsourcing for various departments is based on contractual document defining the business relationship between the client(s) and the shipping company. This also defines full scope and realization of services provided as per agreement.

#### **2.1.1 Administration (Financial management)**

Administration may be referred to as financial management and is part of the shipping company which does not include the actual running of the ships, but more the activities and costs that arises from running the various business unit(s)/department(s). This is to make sure that all financial reports are prepared in accordance with proper accounting practice and there is an adequate level of control on all cash movements. Such matters may be strategic planning, finance planning, accounting, legal, taxation, strategies, and human resources among others.

#### **2.1.2 Commercial management**

Commercial management in a shipping company refers particularly to the administration of revenue and expenses to generate a financial return. It is also to ensure that cargo/passengers are securely transported and optimized in terms of price, position and quality in order to maximize returns. The typical services offered under commercial management are Operation, Chartering, S&P broking and bunkering.

##### **2.1.2.1 Operation**

This includes making sure that the ship is in operational condition, cargo/passengers are properly insured, that fuel and consumables are well onboard, That the ship is in seaworthy condition, and that the ship is well anchored at the port of loading and discharging. Fuel Quality is to be analyzed before use. Quality reports are produced as part of the ship and equipment condition, therefore achieving the best results. In vessel's operation all involved parties from the owner, to managers, to those serving on board are of vital importance and having a safe and profitable vessel is one of the key considerations for any shipping company and thus helps securing the prosperity of all parties involved. In case of operating a ship even if the fleet schedule has been determined, the detailed voyage plan needs to be established. This is the purpose of this function. It is important to note here that during the detailed planning of the voyage, the ETA required to satisfying the agreement between client(s) and commercial manager should be met by sailing in a way that minimizes the use of energy, so to establish and maintain safe working practices including the protection of environment by minimizing use of energy and other consumables. This will keep operational cost down and will reduce emissions of climate gases and particulates.

### **2.1.2.2 Chartering**

The main focus of chartering department is securing the vessels income stream. The chartering department needs to be constantly up to date on the market and market trends because most of the strategic choices of operation are made here. Chartering of vessel can be done in basically four different charter forms.

#### **Voyage charter**

This is the basic charter form, where the owner company makes the ship available to the charterer. By this charter form, the owner carries the main expenses, such as crew, bunkers, port expenses, etc. Furthermore, the owner pays any loading and unloading expenses, etc as agreed in the charter negotiations. In principle the freight payment will be the same amount regardless of how long the voyage takes. Exceptions apply here in particular by the extension or shortening of the loading and discharging time. The consequence is that the time risk is with the owner. If the ship is delayed because of weather conditions, the financial result is correspondingly bad. This charter form can also be used for multiple voyages so-called consecutive voyages. In this case the company shall continuously perform as many voyages as it can manage within an agreed period or a specified number of consecutive voyages, but still the time risk on the owners shoulder.

#### **Time Charter (T/C)**

The second main form, time charter (T/C) makes the ship at the disposal of a certain period, e.g. one year, and it is the charterer who then must find employment for that period. The rate of hire will be for the number Dwt per unit of time or a fixed daily or monthly amount. The time risk rests on the charterer. Hire payment first stops running if the ship is off-hire, usually in cases where the owners can not make a seaworthy ship. Expense allocation is under time charter different to voyage charters. The Owners shall pay for the crew, insurance and maintenance of the ship, in other words, operating expenses, but loading / unloading, port expenses and bunkers are paid by the charterer.

#### **Bareboat charter (Demise charter)**

A third charter form is bareboat charter. In this case the owners are also putting the ship at charterers' disposal for a certain period of time. Charterers obtain the complete control of the ship which they are operating as if the ship belonged to their own fleet. All costs and expenses related to the use and operation of the vessel are for charterers' account, including crewing expenses. Charterers will keep the vessel in good running order and condition and in substantially the same condition as when delivered by the Owners. The Owner will only pay capital costs.

#### **Contract of Affreightment (COA)**

Contract of affreightment or quantity contracts, is a forth form. This form is a variant of voyage charters. It concluded a contract for transport of large quantities over a certain period. Under COA the shipments are not bound to a particular ship, but the owner undertakes with certain intervals to make a ship of an appointment type and size, and that otherwise satisfies the ships requirements as may be agreed in the contracts. Charterers on the other hand undertake to deliver the agreed cargo lots.

### **2.1.2.3 Sale and Purchase (S&P)**

There are two types of acquisition to be considered, new-building and second-hand vessels. If the acquisition is a new-building, there will be a tender and succeeding choice of yard. This is a time-consuming process with building contract specifications, makers' lists as well as supervision of the vessel under construction. When it comes to purchasing through the second-hand market, there is the issue of finding a suitable vessel to satisfy the need of the shipping company. Probably there will be several vessels to fill this space and the choice will reflect the alternative with the best terms to a minimum of costs. In addition there is the other side of the table when it comes to selling on the second-hand market, the interest lies with selling the vessels to a good price. S&P of tonnage belong to the Owner's most important transactions, due to the extreme economic consequences such transactions have, the timing of purchase or sale of tonnage is a crucial factor for the owners.

### **2.1.3 Ship Management**

The main purpose of the Technical management is to maintain and run the ships on a daily basis, safely, efficiently and economically, in accordance with applicable rules and regulations. The objective is to maximize profit and eliminate down time. The assets in the shipping industry is the vessels, they are of great monetary value and need to be preserved properly. If well run, the shipping company earns a great profit from keeping these vessels in business, which makes the technical reliability important. The technical management is developed over time to support and incorporates execution of all activities deemed as vital in obtaining safety, environmental and quality performance and for the sake of continual improvement.

#### **2.1.3.1 Repair and Maintenance**

The objective of maintenance and repair is to maximize the capacity of the ships with minimum off-hire, maintaining quality and schedule regularity.

To keep a vessel running it needs to be maintained properly, daily decisions has to be based on routine and experience. Routines are made according to regulations from flag state, sailing waters, authority regulations, port state control regimes and classification society inspections. In addition the manager has its own policies or the owner has policies that need to be applied through the technical manager/department. Maintenance should be made in accordance with equipment manufactures recommendations and at the same time fit into a daily schedule.

The crew is expected to maintain the majority of the equipment onboard, but still some equipment calls for professional service and has to be undertaken by special personnel.

When and where to make repairs is an important matter and depend on time in offhire, price and quality. The best option would be to do these repairs concurrent with the mandatory class renewal survey or a planned yard visit if docking is required. All periodic surveys have to be planned and carried out in order to comply with class rules and regulations.

Repairs are divided into planned and unforeseen repairs<sup>3</sup>, either way they have to be fixed. Various strategies exist for maintain a ship. In FLAGSHIP the following terms are used for maintenance strategies.

- Corrective – wait until it breaks, then fix it.
- Preventive – maintain it regularly to extend its operating life, thus making the maintenance work cost effective.
- Predictive – maintain it regularly to prolong its operating life, and, in addition, collect and use condition information to maintain/refurbish/replace at the optimum time, taking a holistic view of the vessel rather than considering it to be an agglomeration of parts.

Some repairs may be postponed to the next yard visit, but if this is defensible is up to the technical manger/department to decide. Expenses due to unforeseen repairs has to be factored into the maintenance program, this is done either as a “voyage repair” or it is stored to the next scheduled repair yard call.

A Planned Maintenance System (PMS) is to be established on each vessel. The PMS is to be specifically adapted to the requirements of the vessel depending on type, age and trading pattern and maintained in English language. The status of maintenance standards is frequently reported to shore for review. Shore management monitors vessel status and provides any assistance required. The Fleet Superintendent(s) on shore is to check that the PMS schedule adequately covers the maintenance requirement of the ship. Ship owners prefer a class certified PMS so they are granted with improved facilities for dealing with machinery surveys, and using class certified Chief Engineer survey credits. The effectiveness of the PMS can be checked as part of the routine inspection visit, and to be discussed with the shipboard management team and changes made as required to overcome any deficiencies. All PMS systems shall be designed to meet with: ISM & classification society requirements, Manufacturers recommended overhaul periods, Known main machinery running hours, Flag state survey & specific trade requirements.

### ***2.1.3.2 Stores and Supplies***

Running vessels will at all times need to be supplied with goods of varies types. Equipment and gear for maintaining the vessel, spare parts for the engines and different machinery components has to be kept in stores.

When ordering for stores and supplies there are a lot of things to consider, some strategic issues has to be taken into account as well. Some purchases may profit from having a contract with a specific supplier, others have to be put out on tender. Both ways the price of the purchase has to be weighted against the quality of the goods and the reliability of the supplier in order to put a value on it.

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<sup>3</sup> This project is only concerned with normal shipping, so unscheduled activities such as damage repairs to a ship is not taken onto considerations

### **2.1.3.3 Regulatory environment**

In case of operating any types of ship, a shipping company always make sure that all functional requirements for a safety management system are in place as per international standards so that statutory and regulatory requirements are met. This includes appointment of surveyors and technical consultants as the managers may consider from time to time as necessary.

Instructions and procedures are established to ensure safe operations of ships and protection of environment in compliance with relevant international and flag state legislation. There is a defined level of authority and lines of communication between, amongst, shore and ship board personnel; which includes procedures for reporting accidents and non-conformities as per SOLAS and IMO regulations and procedures. These procedures are established to prepare and respond to emergency situations with compliance with mandatory rules and regulations; and to ensure that applicable codes, guidelines and standards recommended and are met as per ISM code. This International Standard can be used by internal and external parties, including certification bodies, to assess a shipping company's ability to meet statutory and regulatory requirements.

### **2.1.3.4 Crewing**

Crewing is responsible for manpower supply for the recruitment, engagement, training and mobilization of seafarers according to defined International procedures and standards. Crew management is undertaken by Crew Department. This department always makes sure that all seafarers and merchant marine officers serving are highly skilled and are aware of their duties while they are onboard ship. The Master of a ship always makes sure that the prime communications link on crewing issues is established and maintained with the shipping office and maintained as undertaken and advised by Crew Management. In any shipping company crewing makes a vital difference in achieving shipping company's goals and targets while developing ship board organization. Crewing in a shipping company always make sure for Crew Welfare, their training, appraisals, promotions, discipline, Drugs and Alcohol usage and other major issues involved while the international standards are maintained on-board. The crewing is also responsible to provide all ITF/Union guidelines to crew and make sure that under Talent Management these officers are sustained and well trained further to compliance of safety management procedures, this also include vessel account and administration.

## **2.2 Outsourcing**

### **2.2.1 Introduction**

Outsourcing is defined as “procurement of products or services from sources that is external to the organization” (Lankford and Parsa, 1999). In product outsourcing it will be buying a product from a manufacturer where as in services outsourcing it is more related to transfer of operational control to the outsiders known as suppliers. It is difficult in today's economy and business world to control and provide services internally. It is suggestive that competitive advantage can be gained when products and services are outsourced from the suppliers who are outsiders but preferences is towards cost effectiveness and efficient delivery of services on time. This is the reason that managers look into outsource and commend third parties. The advantages of outsourcing can be strategic and operational. The short term trouble avoidance can be achieved

via operational advantages however the strategic advantages will be to maximize opportunities with long term contributions.

## **2.2.2 Background 3rd party Technical Ship Management**

### **2.2.2.1 Outsourcing of Ship Management Services**

The establishment of technical ship management in maritime industry has existed since vessels have been created, but in early 1970's the outsourcing operations instigated as the shipping companies were focused on outsourcing non-core services. The attractiveness to outsource services to 3rd party technical ship management companies is increased because of various reasons such as shipping has become more a part of the logistic supply chain. Similarly the innovation and improvement in technology has increased the demand of skilled individuals and specialized equipment therefore demand of skilled workers at sea and ashore are required. The technical ship management companies developed over time the need to clarify their position as a specialist provider of a wide range of support services. In addition the role of the technical ship manager has become more complex through the years. It started in the eighties when there was a profound change in the market as many shipping companies became bankrupt and mortgagor banks had to turn to ship managers for help. It continued in the nineties with a new type of investor in shipping with little knowledge of ships and more recently with the implementation of the ISM Code in 1998. The result was an uncertain situation with profusion of in-house contracts without any uniformity, particularly in the apportionment of liabilities between the parties. On the other hand outsourcing of the daily operation has become more and more common the last decades. *“Up to 25% of the world's fleet is under some sort of 3rd party ship management today and this number is expected to grove to about 35% of the world fleet in the next five years”*<sup>4</sup> The advantages to outsource to third party technical ship management lies within expertise and knowledge, market presence, bargaining muscle and economy of scale.

### **2.2.2.2 Contracting practices in ship management.**

In 1988 BIMCO published the first SHIPMAN, a Ship Management Contract that provided the market with a standard document striking a fair balance between the rights and obligations of the owners and the managers. The contract has been a success and is today a widely used standard ship management agreement. Given the importance of SHIPMAN to the ship management sector BIMCO has undertaken a revisions (1998 and 2009) of the agreement in order to reflect and maintain the latest ship management practice and legal developments

In today's types of ship management contracts, operation costs are reported daily, monthly or annually. The cost structure is schematized below. The figures are from a new Handymax Bulker (Dwat 54 000) and are from this year. The dry docking and insurance costs are not included in the daily operational cost overview.

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<sup>4</sup> [http://www.shipmanagementinternational.com/files/smi\\_issue14.pdf](http://www.shipmanagementinternational.com/files/smi_issue14.pdf)

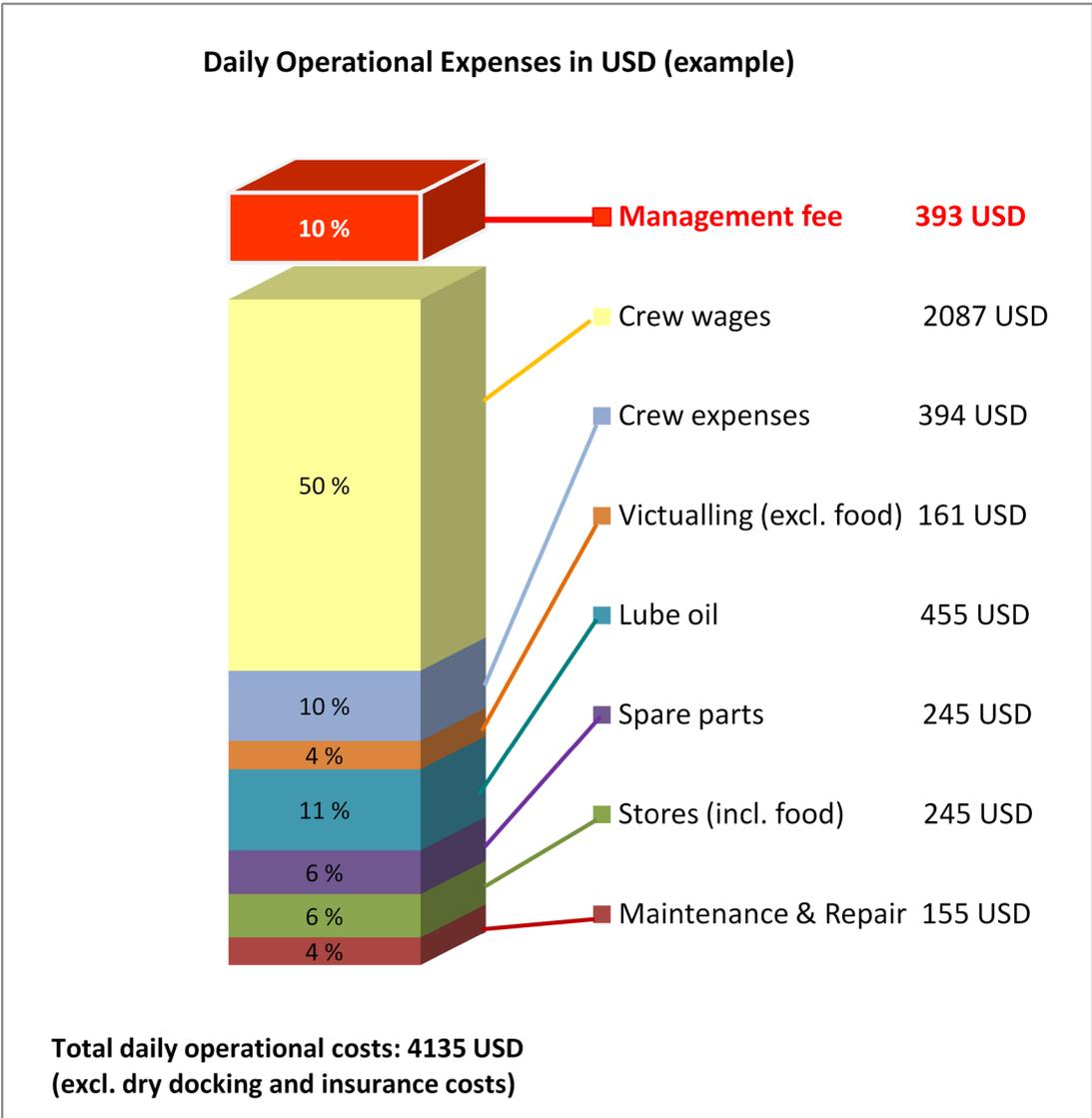


Figure 1: Daily operational costs<sup>5</sup> for a handymax (54 000 Dwt) in % and USD, figures from 2011.

2.2.2.3 Ship Management firms struggling with rising costs<sup>6</sup>

The costs of ship management companies are soaring owing to the growing volume of onshore works related to ship management against the backdrop of the reinforcement and increasing complexity of regulations.

It has also been pointed out that the hike in the salaries of seafarers (ship officers) is promoting the increase in the wages of ship superintendents and other land-based marine engineers.

While numerous ship management companies have won the understanding of their ship-owner customers and are slowly raising their ship management fees, the fact remains that the ship-owners are in no condition to proactively accept the surge in fees. In light of this, the ship

<sup>5</sup> This particular case is from 2011 and an actual shipping company in Europe. Here, the management fees are of USD 393, which would be potentially put at risk if the manager enters into a Performance-based Contract. This will be further investigated in the Demonstrator in section 6.

<sup>6</sup> Source: InterManager

management companies are tackling cost reduction by adopting the economies of scale and pursuing increased efficiency and performance in works and operations.

The revenues of ship management companies come from the ship management fees. These companies cover the general management costs (of their own companies) with these fees, but their costs have been on the rise owing to such factors as the growing complexity in the regulations, while constantly facing intense competition.

In light of the above, given that the ship owners reap the benefits of high-quality ship management, the fees should be linked to the performance achieved by the ship management companies.

### **2.2.3 KPIs and 3rd party Technical Ship Management**

Outsourcing has appeared to be very productive way for organizations to increase efficiency, but it is important that companies must have a strong control over their functions which are outsourced or managed externally. For example there is a risk of losing suppliers as third party management companies will deal with the suppliers and organization will lose that control they had over their suppliers. As mentioned above there are advantages of outsourcing but on the other hand the risks involved can not be ignored. Hence there must be procedures implemented to enable the organization to evaluate, monitor and control the performance of the third parties.

The ship owners need to make sure service delivered by the technical ship management companies' are up to the standards of agreed and/or industry levels. Therefore contracts and agreements with KPI initiative concept is been introduced like in many other industries to promote the ship owners and managers to work more efficiently and cost-effectively.

It is very important to understand the concept of "Performance management" and its evaluation. Key performance indicators (KPIs) are used as a tool in performance management to determine performance of businesses and the effectiveness of processes by collecting and analyzing appropriate data from monitoring, measurement and inspection the company.

As outsourcing of technical ship management is a relatively 'new' business there are no international standards for measuring operational performance in ship operation. The lack of an international standard for ship management operational performance reporting has led to a situation where many companies are defining, measuring, and reporting performance information differently. It exists several key performance indicators (KPIs) in the industry and many companies use their own indicators to promote their services or use for internal benchmarking.

In order to improve the situation, InterManager created a group of 18 leading ship management organizations and ship owning companies that agreed to cooperate to establish a global industry standard for KPIs in the shipping industry. The Shipping KPI project<sup>7</sup> has been focused on the technical ship management and in particular third party ship management. The scope of the project has been to propose a global shipping industry standard for measuring and reporting information on operational performance.

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<sup>7</sup> <http://www.shipping-kpi.com>

The Shipping KPI performance measurement standard aim at:

- Boosting performance improvements internally in companies engaged in ship operation activities
- Providing an efficient communication platform for ship operation performance to internal and external stakeholders

### 3 Performance-based Contracting

This chapter presents a literature review of theories and practical applications related to performance-based contracting in a series of sectors. The most relevant findings from a Ship Management perspective are reviewed in the next chapter in order to highlight important concepts, principles and dilemma that will be necessary to take into account when designing a performance-based contract for technical ship management.

#### 3.1 Introduction

The present literature review is conducted for application of PbC to Ship Management. Therefore, rather than an exhaustive Delimitation: for application to ship management contracting, i.e. not completely complete review of all theories, concepts and examples related to PbC, only the ones that appear to be relevant for applying PbC for Ship Management are covered.

The main databases used for the review are EBSCO Business Source Alumni Edition, Science Direct, Springer Link, Google Scholars, and partially Emerald Insight. 35 publications were reviewed.

When exploring PbC, there are a multitude of elements that arise, including concepts, theories, practices, etc. In order to understand the context of PbC and delimitate the exploration of PbC, a mental map encompassing main relevant elements has been suggested.

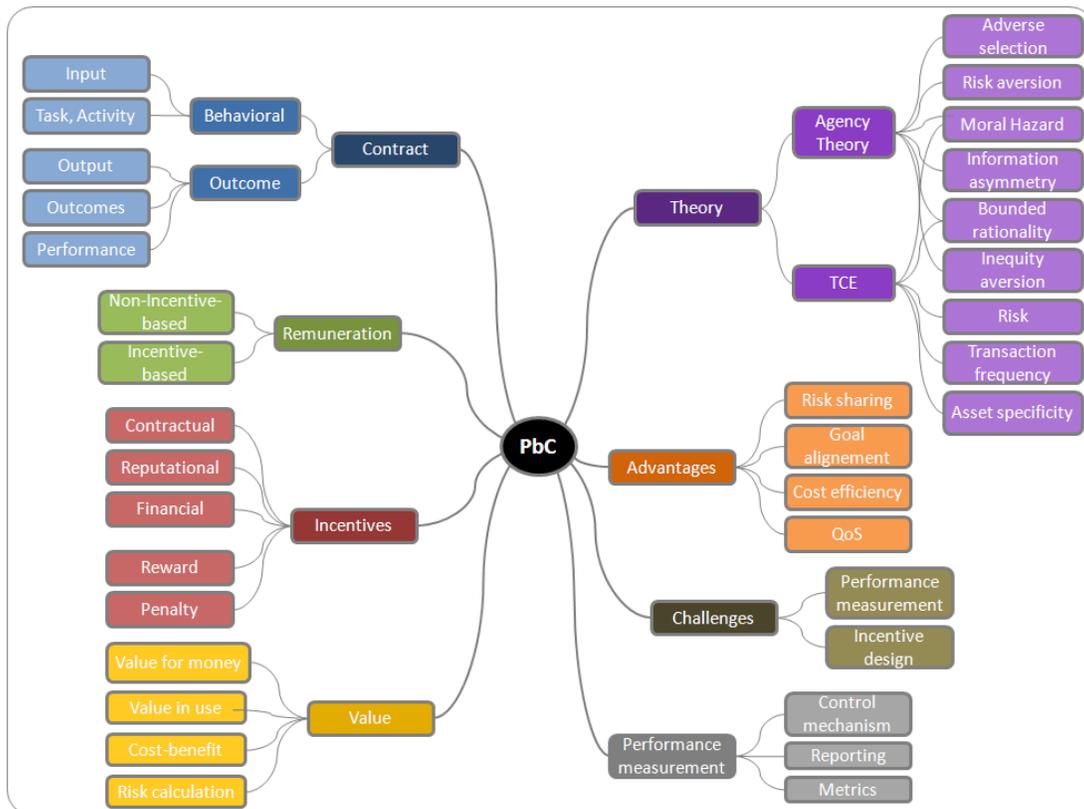


Figure 2: Scope of literature review on PbC

## 3.2 Contracts

This section presents a brief introduction to contracts.

### 3.2.1 Definition

*Contracts* are “formal mechanisms of management control” (Homburg & Stebel, 2009:129, referring to Anderson and Dekker, 2005). They consist of a (often) written set of agreed-upon rules used to monitor a transaction in a formal manner, as opposed to, for instance, verbal agreement.

According to Domberger (1998:12), *contracting* refers to “both the process of outsourcing – the search for and appointment of contractors for the provision of goods and services – and the execution of the contractual relations needed to support such activities” (cited in Hypko, et al., 2010).

The evolution of contract theory can be briefly summarized as follows (see Hooper, 2008):

- Start of 20th century: the ‘Edgeworth box’ is used to draw contract curves showing the range of mutual trading benefits from two parties
- 1950s: specific consideration of situations involving uncertainty.
- 1970s: study of contracting based on information asymmetric and beginning of theory of incentive contracting.
- 1980s: focus on dynamic contracting (repeated over time) and start of transaction-cost-economics (Williamson, 1985)

### 3.2.2 Types of Contract

The most common forms of contracts used across industries can be divided into fixed-price and incentive-based contracts, and are presented below.

#### 3.2.2.1 *Non-incentive contracts*

- **T&M** (Time and Material)

Cost-plus contracts where the services of the vendor are bought at a specified billing rate (Gopal & Koka, 2010)

- **FFP** (Fixed-Fee Price), **Lump sum**, **FFC** (Fixed-Fee Contract), **FP** (Fixed-Price contract), **FFP** (Firm-Fixed Price), **Fee-for-service**

This is a contract type for which the vendor performs a specific service at an agreed fixed amount. Not subject to readjustment.

Under FFC, the vendor is responsible for all the risk of cost overruns, but can improve efficiency and make higher profit (Osei-Bryson & Ngwenyama, 2006).

Despite of commonly acknowledge risk of opportunism from the vendor in the literature, Gopal & Koka (2010) argue that strong incentives (fear of cost overrun, targeted higher

margin) in FP contracts motivate the vendors work more efficiently and effectively. So, even though FP are not incentive-based contracts, they motivate the vendors such that they often deliver higher quality, notably due to the staffing of more qualified personnel, as opposed to T&M contracts which represent no risks of cost overruns and which are therefore often staffed by less qualified personnel, resulting in lower quality (Gopal & Koka, 2010). In conclusion, both clients and vendors have reasons to prefer the FP contract over T&M.

- **CPFF**<sup>8</sup> (Cost-Plus-Fixed-Fee), **CPPC** (Cost-Plus-Percentage of Cost)

CPFF is a contract form where the contractor is paid a fixed fee in addition to reported costs or. CPPC is similar, but in which the additional payment is not fixed, but a percentage of the cost.

This type of contract provides no incentive to the contractor and leaves all the risk upon the customer. T&M contracts (Time and material) are a special case of CPFF; they transfer all cost overruns to the client, while providing no incentive to the contractor to increase efficiency or effectiveness. Vendors' preference for T&M is mainly explained by the absence of risk. (Gopal & Koka, 2010)

### 3.2.2.2 *Incentive contracts*

Incentive contracts (McCall, 1970) are contract under which the contractor's benefit depends directly on the customer's benefit. This type of contract enables sharing risks and reward.

Performance-based Contracts are incentive contracts in which reward and penalty scheme is defined based on the performance delivered/ensured.

- **FPIC** (Fixed price incentive contract), **FPI** (Fixed-Price-Plus-Incentive Fee)

Contract under which the target profit depends on both the targeted costs and an agreed-upon sharing proportion. The savings realized (target costs minus actual costs) are shared based on an agreed ratio (McCall, 1970; Al-Subhi Al-Harbi, 1998).

This type of contract is relatively complicated, but enables a reasonable sharing of risk, while providing sufficient incentive to the contractor for increasing efficiency.

Under a FPIC, both outsourcer and vendor know the costs.

- **CPIF** (Cost-Plus-Incentive-Fee), **CPIC**: Cost-Plus Incentive Contract, **VPIC** (Variable price incentive contract)

Contract under which a specific rate of profit for a given level of performance is agreed, together with an incentive payment for higher levels of performance.

VPIC is commonly used when the costs are unknown (Osei-Bryson & Ngwenyama, 2006)

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<sup>8</sup> **CPC** (Cost-Plus Contract) include both non-incentive (CPFF, CPPC) and incentive contracts (CPIF, CPAF)

- **CPAF** (Cost-Plus-Award-Fee)

The contractor is paid all reasonable costs, plus an award fee based on the contractor's work performance (non specific, but may be the service outcome, quality, savings realized, or even the contractor's behavior), defined by an award committee.

This type of contract is more subjective than CPIF, and therefore more flexible, but is relatively more costly in administration.

It is important to note that there is no best contract. The decision related to the right type of contract types and the adoption of incentive-contracts depends on the characteristics of the transaction, of the service, but first of all on the parties' attitude towards risk. Basically, risk averse managers prefer fixed-price contracts, while less risk-averse managers are willing to put at stake their future benefits with the expectancy of higher benefits or reduced costs than with a fixed-price contract. Once the contract type is chosen, firms can "address their quality issues [...] by understanding the role of incentives and risks within these contractual regimes" (Gopal & Koka, 2010: 512).

All types of contracts can be ranked according to the level of risk for both the client and the contractor, as illustrated in Figure 3. PbC are incentive-based contracts, neither fixed-price only nor cost-reimbursement contracts, they enable sharing of risk between the owner and the contractors. Although it is argued that performance-based contract are variable-cost contracts (Homburg & Stebel, 2009), not all variable-costs contracts are necessarily PbC.

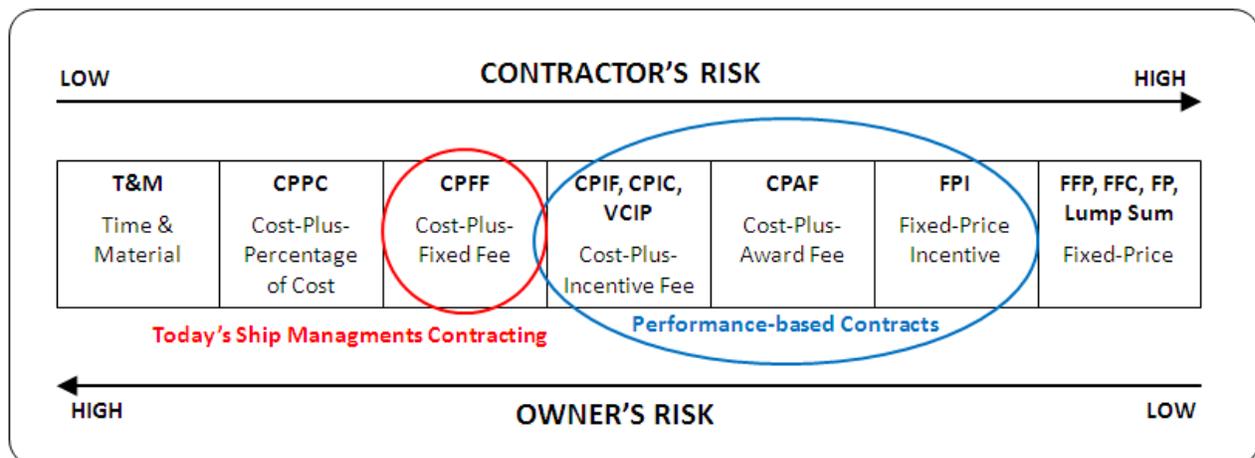


Figure 3: Contract type and associated risk (adapted from Al-Subhi Al-Harbi, 1998)

As indicated in the figure, and in light of the description of current practices made in chapter 2, ship management contracting can be located in the figure as very close to Cost-Plus-Fixed-Fee contracts, which represents a relatively high risk level for ship owners.

### 3.3 Understanding PbC

This section presents the definition for Performance-based Contracting, historical background of the concept, as well as common Pros and Cons to its application for service outsourcing.

#### 3.3.1 The concept of PbC

The most complete definition of PbC is the one from (Martin, 1999: 8; cited in Martin, 2010: 4):

*A performance-based contract is one that “focuses on the outputs, quality and outcomes of service provision and may tie at least a portion of a contractor’s payment as well as any contract extension or renewal to their achievement”.*

In practice, Performance based contracts (PbC) or Service Level agreements (SLA) refers to an *agreement between two parties for delivery of products or service where payment is directly related to the performance* (Baker 1992)

Performance-based service contracting (PBSC) emphasizes that all aspects of an acquisition be structured around the purpose of the work to be performed as opposed to the manner in which the work is to be performed or broad, imprecise statements of work which preclude an objective assessment of contractor performance. It is designed to ensure that contractors are given freedom to determine how to meet the Principal’s performance objectives, to ensure that appropriate performance quality levels are achieved, and that payment is made only for services that meet these levels. (ref. DOE: Performance base contracting Guide 1998)

*“the customer really doesn’t want a drilling machine, he wants a hole-in-the-wall”* (Levitt, 1972, HBR)

Performance based contracting is a method of contracting where a Principal defines the results it is seeking, rather than the process by which those results are attained. Also included are the standards against which contractor performance will be measured, and positive and/or negative incentives (Rogin, 2001).

PbC has arisen as an alternative to FPC and CPC for improving performance and reduce risk by “tying a supplier’s compensation to the output value of the product generated by the customer” (Kim et al, 2007: 1843)

Synonyms to PbC in practice include: Performance contracting, outcome-based contracting, output-based contract. What differentiates PbC from more specialized outcome- and output-based contracts is that both are encompassed in a PbC, *outputs* referring to units of service, indicating the amount of service provided, and *outcomes* referring to the accomplishments or impacts of service delivery (Martin, 2010).

Although the primary goal of PbC is to create incentives for contractors to perform better, important rationales behind the concept of PbC include:

- PbC “allows the contractors to determine how best to achieve those outcomes, rather than prescribe the methods contractors should use” (GAO 2003: 1; in Terman & Yang, 2010), as reducing contract management efforts has been one of the main reasons the US Government has pushed towards higher use of PbC.
- PbC fosters “innovation among providers by reducing regulations and requirements around process or program design, while maintaining accountability through increased monitoring of outcomes (Frumkin, 2001).; which is typically relevant for the outsourcing of social services from public agencies to service providers (Hannah et al., 2010).

- PbC enable the transfer of responsibility (a change of “ownership”) to the contractor and view service delivery as a result than an action; this is typically important in the manufacturing industry’s outsourcing of maintenance and repair, for which ensuring in-service (availability of equipment) is the ultimate goal. (Datta & Roy, 2010)

The main objectives of performance based contracts are to improve quality and reduce costs. In order to achieve these goals an effective PbC need to be well defined, with clear written statement of work and achievable performance standards. In addition, one need to define a performance requirements summary that sets the performance standard for each measurable service of the contract and defines acceptable quality levels, methods of measurements and percentage of the contract price each service represents to establish the basis of payment for acceptable and non-acceptable performance .

### **3.3.2 Origin - A US-born concept?**

The practical application of pay-for-performance in contracts in order to reduce monitoring efforts can obviously been traced back to the USA. Still, the interest in PbC in academia and among practitioners has spread worldwide and across industries. For instance, the reference list of the present review includes: approximately 45% of authors from non-US institutions (Germany, Australia, Norway, India, Canada, Italy...), and 40% of the cases analyzed are non-US cases (Norway, Australia, Germany...) although the US public service sector is still dominating a large part of academic research.

#### **1960s:**

- US Department of Defense – pioneer in use of Performance-based contracting (Marcus, 1964; Ng et al., 2009; OFPP, 1998); “incentives to produce good performance” and “incentives apart from profits to induce innovation”(Marcus, 1964; in Ng et al., 2009)

#### **1980:**

- Big wave of outsourcing of governmental services in US (Terman & Yang, 2010)
- Increase of PbC (by the federal Government) for coping with difficulties in contracting, notably with regards to monitoring and control (Frederickson and Frederickson 2007; in Terman & Yang, 2010)
- Late 80s: need for research on service contracts that reduced customer risk (Hypko et al., 2010)
- SLA: late 80s. SLA used by telecom operators. Today used in all industries; but still mostly related to IT services, Cloud computing

#### **1990:**

- A mandate of the US Government to use PbC (Robinson, 2005)
- Wave of competitive tendering and outsourcing of services previously supplied by governments (typically health and transport services) with the primarily aim of reducing

public expenses, increase cost efficiency, not necessarily outcome/performance (Hensher and Stanley, 2003).

- PbC, a technique used as a pressure mechanism (on contractors) and “to reap the benefits of the private sector” (Newell, 2008)

**2000:**

- Academicians refers to a “current change of focus” from traditional contracting towards PbC (Kim et al., 2007; Ng et al., 2009; Hypko et al., 2010) which suggests that there is still a long way to go for PbC to be a common and easily implemented practice; in addition to a clear need for further research regarding the establishment of PbC, the evolution the customer-supplier relationship tied by a PbC, etc.
- PbC still big trend in public management outsourcing the production of goods and services to the private sector (Hensher & Stanley, 2008; Ng et al., 2009; Terman & Yang, 2010)
- In 2007, 45% of US agencies used PbC for service outsourcing.

**3.3.3 Pros and Cons**

The table below presents a summary of main Pros and Cons of PbC from point of view of both customers and contractors, based on the literature review.

	PROS/ADVANTAGES	CONS/DRAWBACKS/CHALLENGES
<b>CUSTOMER OFFEROR PRINCIPAL</b>	<ul style="list-style-type: none"> <li>• Better value for money</li> <li>• More focus on outcome rather than cost-reduction only, and more control of payments</li> <li>• Goal alignment, as divergent as they may be. (agent’s goals align on those of the principal)</li> <li>• Cost efficiency: less monitoring, less detailed regulation, less audits</li> <li>• Sharing / better allocation of risks</li> <li>• Sharing / better allocation of responsibilities</li> <li>• To reduce failures and bad performance</li> <li>• To reduce costs of delivery failures (through penalties)</li> <li>• Counteract adverse selection</li> <li>• Better control</li> <li>• Dealing with information asymmetry: the agent knows its business better than the principal, and receive more freedom of action</li> <li>• Self-selection (access to the right competence)</li> </ul>	<ul style="list-style-type: none"> <li>• Allocative efficiency: When contractors only put efforts on areas for which they have more benefits</li> <li>• Risk of lower performance: contractors may take shortcuts</li> <li>• Difficult to implement in practice</li> <li>• Complicated performance measurement</li> <li>• Gains from switching from behavior-based contract not clear</li> <li>• Imposing the measurement of outcome without consensus may have negative consequences (even less effort, lower performance)</li> <li>• perception that the contractors will try to save money by neglecting less visible, however, essential maintenance work (allocative efficiency)</li> </ul>
<b>SUPPLIER CONTRACTOR AGENT</b>	<ul style="list-style-type: none"> <li>• Sharing of rewards</li> <li>• Increase profitability over time</li> <li>• More equitability (reward, profitability...)</li> <li>• More discretion over the service delivery (more power of decision; freedom in action)</li> <li>• Provide targeted performance goals and help the suppliers prioritizing their efforts</li> </ul>	<ul style="list-style-type: none"> <li>• Higher risk / responsibility</li> <li>• Problem regarding when the service is co-created with the customer</li> <li>• No easily measurable outcomes, thus difficult to use PbC to counteract the self-interested nature of the P-A relationship.</li> <li>• Some specific investment may be “imposed” on the contractor for establishing performance measurement and reporting</li> </ul>

**Table 1: Advantages and Challenges related to the use of PbC**

Note that these Pros and Cons elements regard PbC in general, and have been collected in articles on several distinct sectors, thus not specific to shipping. A similar Pros / Cons matrix on PbC for Ship Management is proposed in chapter 3.4.2.

### 3.4 Theoretical foundation of PbC

Contracts have primarily been examined through the viewpoints of agency theory and transaction cost economics (TCE) (Gopal & Koka, 2010)

#### 3.4.1 Agency theory

The Agency theory (Fama & Jensen, 1983) focuses on the transaction established when a principal delegates a job to an agent, and deals with the problems related to their divergent interests, goals and attitudes towards risks. The **principal-agent** (or Agency) theory proposes the contract design as a key mechanism to mitigate the problems (Gopal & Koka, 2010). Goal congruence is actually a prerequisite for contracts to be useful, the principal expecting performance and the contractor expecting rewards (Logan, 2000; in Tate, et al., 2010).

Agency Theory distinguished between two main governing **contracts**, behavior-based and outcome-based contracts, that may optimize the transaction (cost efficient, higher performance etc) (Eisenhardt, 1989).

- *Behavior-based* contracts link the agent's remuneration to the working process, tasks and agent's behavior. Most often a fixed-cost contract, it is appropriate when the agent's actions can be verified, thus more likely to meet the principal's expectations.
- *Outcome-based* contracts link the agent's remuneration to the results / outcomes provided by the agent. This is a variable-costs contract that is incentive-based and enables co-alignment of goals – by making the agent's profit and future business expectations directly dependent on the performance delivered - while transferring some risk to the agent.

The main **assumptions** (about human nature) of the Agency theory (Eisenhardt, 1989) are:

1. *Self-interest*: any principal or agent is believed to act on its own interest, which automatically may result in goal conflicts.
2. *Bounded rationality*: refers to the fact that actors are assumed to be intendedly rational, but only to a limited extent no manager or firm is able to acquire complete information at all times, which make the verification of the agent's work by a principal difficult and expensive.
3. *Risk aversion*: when risk is avoided unless compensation. Attitudes towards risk vary among managers and firms, which result in risks conflicts between principals and agents.

**Information asymmetry** is a typical source of agency problems, i.e., when the agent or principal has private information about the effect of his actions that the other party cannot know about (Baker, 1992). Such information asymmetry results in two main kinds of agency problems (Eisenhardt, 1989):

1. *Adverse selection*: an ex ante problem (previous to the contract establishment) caused by the impossibility to verify the skills and information about the agent when hiring him/her.
2. *Moral hazard*: an ex post problem (after the contract is established), linked to the difficulty in verifying the actual work and coping with possible lack of efforts by the agent. Moral hazard is handled by rewarding good performance (bonus payment, stock option, piece rates..) and punishing bad performance (penalty payment, contract termination, layoffs).

To summarize, the following table links the characteristics of the transaction to the most appropriate contract, according to the Agency theory:

	<b>Behavior-based contract</b>	<b>Outcome-based contract</b>
<b>Goal conflicts</b>	High	High
<b>Risk, uncertainty</b>	High	Low
<b>Information availability</b>	High	Low
<b>Verification of behavior</b>	Easy	Difficult
<b>Programmability of the task</b>	High	Low
<b>Verification of outcome</b>	Difficult	Possible
<b>Risk aversion</b>	Agent	Agent, Principal

**Table 2: Contracts and transactions characteristic according to the Agency theory**

Finding the right incentives is crucial for outcome-based contracts to successfully overcome the agency problems due to information asymmetry. Even if the agent is to bear more risks, it is believe that incentives and rewards can suffice for outweighing this additional risk level (Hensher & Stanley, 2008).

However, the big challenge associated with outcome-based contract in the establishment of robust and useful performance measurement, being based on targeted outcomes, marginal value and costs, or industry benchmarks (Hensher & Stanley, 2008)

### 3.4.2 Transaction Cost Economics (TCE)

Transaction Costs Economics (Williamson, 1985) is dealing with the cost of entering in transaction with others. In TCE, the unit of analysis is the transaction.

TCE distinguished between three main **types of transactions**, with distinct degrees of hierarchical forms:

- *Market: outsourcing*
- *Hybrid*
- *Firm: in-sourcing*

The higher the asset specificity, the more relevant the hierarchical form. When choosing market (outsourcing), contract becomes vital.

The main assumptions in TCE are:

- *Opportunism, an even more serious problem when it regards specific assets*

- *Bounded rationality, high uncertainty: no possibility to cover it all.*

Transactions are characterized by:

- *Level of asset specificity (physical, human, brand, site...). Asset specificity refers to special investment, resource, physical asset, human asset, etc. that are specific to the transaction and cannot be reused without additional costs. (Williamson, 1996). It can be expected that the longer the transaction and more specific the contract, the most likely the specific investments (Large, 2011). Asset specificity implies a higher value of the asset in during the transaction than otherwise.*
- *Degree of uncertainty*
- *Frequency of transaction.*

TCE estimate that the market is the most efficient transaction solution, but also acknowledges that bounded rationality and opportunism are obstacles to effective contracts. (Williamson, 1985).

To summarize, the following table links the characteristics of the transaction to the most appropriate contract, according to TCE:

	<b>Market / Outsourcing</b>	<b>Hybrid</b>	<b>Firm / in-sourcing</b>
<b>Asset specificity</b>	Low	Medium	High
<b>Risk, uncertainty</b>	Low	Medium	High
<b>Frequency of transaction</b>	High	Medium	Low

**Table 3: Three types of transactions and their characteristics according to TCE.**

### 3.4.3 Related concepts and principles

#### 3.4.3.1 *Utility*

Since risk can be measured by a utility function, indentifying utility functions of each party is necessary in order to identify the most appropriate contract and payment model (Hooper, 2008).

#### 3.4.3.2 *Revelation and Self-selection principles*

To deal with the problem of adverse selection, under which a party retains some private information and can lie about their capabilities or willingness to accomplish a job, the revelation principle consists in designing “one [incentive-constrained] contract for each type of information that the informed party may have, making sure that each type has an incentive to select ‘from the menu’ only the contract that is destined for them” (Hooper, 2008: 158).

This principle is in line with the *self-selection* principle (Lazear, 2000), stipulating that incentives may help for getting access to specific agents (qualified workforce, supplier etc). By defining clear goals, only the agents who can deliver the expected results, and know it, will seek for the job (Zhao, 2008).

#### 3.4.3.3 *Multiple tasks moral hazards: Effort substitution and allocative efficiency*

In multiple-tasks contracts, “the principal must also worry about how incentives to undertake one task affect the agent’s incentives to undertake other tasks” (Hooper, 2008: 158). The agent

therefore can be tempted to overemphasize a task in preference to another, because the final gain may be still higher than when performing both tasks equally.

This is referred to as the *effort substitution* problem (Holmström & Milgrom, 1991; Zhao, 2008) or *allocative efficiency* (Fearnley et al., 2004), i.e. when contractors only put efforts on areas for which they have more benefits.

#### **3.4.3.4 Low-powered incentive contract**

This refers to a multiple-task contract in which the outcome of one (or some) of the tasks can not be observed or measured Williamson (1979), resulting in poor performance on this particular task offsetting the good performance on the other (measurable) tasks. In such situation, Holmstrom and Milgrom (1991) suggest *not* to give incentives at all (Hooper, 2008).

An alternative way to deal with low-powered contracts is to modify the performance measure of some tasks (e.g. lower reward), in order to mitigate the incentives to work harder on well-measured tasks with a measurable outcome and less on other tasks (Holmström & Milgrom, 1991; Zhao, 2008).

#### **3.4.3.5 Dynamic<sup>9</sup> adverse selection Hooper, 2008**

While *adverse selection* is a problem concerning the pre-contract phase (ex ante), this problem becomes recurrent when the contract transaction is repeated over time, precisely because dynamic contracting allows for re-negotiation (Hooper, 2008). On one side long-term relationships enable the development of trust, which are a valuable *supplement* to contracting (Poppo and Zenger, 2002). However, experience from strategic alliances suggests that forcing a partner to commit can have a negative effect on motivation and commitment and that it is preferable to create win-win situations and share benefits of collaboration in order to develop commitment (Bresnen and Marshall, 2000).

Still, relationships that are very close and through which the principal can observe the working process and agent behavior can offset the incentive-mechanism. So, to cope with dynamic (repeated) adverse selection, it is better for the principal to keep the agent at ‘arm’s length’, and keep focusing only the output (Cremer, 1995; Hooper, 2008:168), as a condition for payment and future contract allocation.

#### **3.4.3.6 Dynamic Moral hazard**

While *moral hazard* is a problem concerning the post-contract phase (ex post), this problem changes when the contract transaction is repeated over time, precisely because dynamic relationship affects the contract’s premises (better information, more transparency, more trust, less risk aversion...) and therefore the incentives (Hooper, 2008).

On the other side, this repeated contracting may give so much freedom to the agent that (s)he may start to “choose when to work and can offset a bad performance in one period by working harder in the next period” (Hooper, 2008: 160). This can justify the necessity to establish incentive contract based on individual as well as cumulative outcomes.

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<sup>9</sup> See the *Dynamic principal-agent model* developed by Holmstrom & Milgrom (1987)

### **3.4.3.7 Efficiency-challenges**

X-efficiency (or technical efficiency) refers to “continuously making an operator produce a given output in a cost efficient manner (Martin, 1978; Fearnley et al., 2004: 30). Incentives for X-efficiency can increase the risk of allocative efficiency in multiple-tasks contracts. The principal must find a balance between requiring cost efficiency and expecting equal performance on each task (Fearnley et al., 2004).

### **3.4.3.8 Service co-creation**

Given the intangibility of a service and the fact that service is always delivered for increasing the performance of the client itself, services are typically co-created / co-produced by the contractor and the client (Vargo & Lusch, 2004; Ng et al., 2009). This involvement of the client in the value creation is also referred to as the concept of integrativity (Homburg & Stebel, 2009).

### **3.4.3.9 Contract complexity and negotiation**

Covering all contingencies and specifying all resulting payoffs in a contract is impossible (Tirole, 1999; Gopal & Koka, 2010). Besides, very complex contracts are more likely to encounter problems of misinterpretation and an expensive monitoring process.

Negotiation should not be underestimated (Hensher & Stanley, 2008), and should be used to reach a common agreement on design appropriate contractual parameters, including a set of incentive rules that are objective, not easily manipulated, and not subject to favoritism (Hensher & Stanley, 2008).

Finally, the contracts' performances depend also on the previous contracts' achievements and the way these have affected the transaction.

### **3.4.3.10 All-or-nothing monitoring**

Designing one joint output measure to motivate all tasks simultaneously may help to cope with moral hazard and is required when the agent faces limited liability (thus tempted to look for short-cuts or to give preference to some tasks over others (Zhao, 2008). Based on evidence from incentive-schemes in organizations, Zhao (2008) argues that when at least one task cannot be monitored, it is more optimal to revert to outcome-based contracts for all tasks than a mix of behavior- and outcome-based contracts. “Rewarding the overall outcome is more efficient than paying for piecemeal actions” (Zhao, 2008: 1627).

However, this proposal is not universal and in case of large asymmetry among tasks, it seems better to use monitoring.

## **3.5 PbC in practice**

In practice, most companies use risk and reward incentives in outsourcing contracts: 60% of companies world wide do this, according to a survey of Accenture and The Economist Intelligent Unit (Arif, 2004).

Based on a review of publications focusing on PbC and related concepts, this section provides a selection of relevant industries and social sectors which have adopted PbC or PbC-like contracts (income-based contracts etc), highlighting the main characteristics of the transactions, the

reasons for using PbC and related challenges. In the next chapter, a summary table exposes some lessons-learned from each sector and implications for PbC in Ship Management (main particularities of each sector and relevance for Ship Management).

### 3.5.1 Defense, Aerospace

<u>Relationship</u>	Governmental agency – Manufacturer
<u>Assumptions</u>	<ul style="list-style-type: none"> <li>• T&amp;M or Fixed-price contracts limit considerably performance and innovation</li> </ul>
<u>Benefit of PbC</u>	<ul style="list-style-type: none"> <li>• PbC in defense and aerospace have been established with the purpose of reducing costs, increasing efficiency, and improving performance (Hypko, et al., 2010)</li> <li>• A best-practice example is Rolls Royce’s Power-by-the-hour, which links the payment for engine M&amp;R services to the availability of the engine (in hours) rather than reimbursing for spares and repairs (Ng et al., 2010)</li> </ul>

(References: Hypko, et al., 2010; Ng et al., 2010)

### 3.5.2 Insurance

<u>Relationship</u>	Insurance company (insurer) – Client (insuree)
<u>Assumptions</u>	Evidence of adverse selection and moral hazard (fraud)
<u>Benefit of PbC</u>	Changes in the payment structure and amount, i.e., cost sharing, helps to cope with moral hazard and misuse

(References: Hooper, 2008)

### 3.5.3 Labor economics

<u>Relationship</u>	Employer – Employee
<u>Assumptions</u>	Moral hazard, adverse selection, Inequity aversion (concern for a fair distribution of profits)
<u>Benefit of PbC</u>	<ul style="list-style-type: none"> <li>• Modifications in workers’ incentives can improve productivity</li> <li>• All-or-nothing monitoring: use PbC for reducing costs and ensuring performance is most appropriate when not all tasks can be monitored.</li> <li>• Tendency toward linear-sharing rules (Englmaier &amp; Wambach, 2010)</li> <li>• But evidence of risk of lower performance in case of linear sharing (demotivation). Holmström (1982) showed that a sharing rule that distributes the entire output among contracting parties cannot implement the first best result.</li> <li>• Self-selection: PbC good for selection of competent and qualified workers</li> <li>• Externally determined performance standards are less affected by management actions and better than unproductive incentives like budget-based (Murphy, 2001).</li> </ul>

(References: Englmaier & Wambach, 2010; Holmström, 1982)

### 3.5.4 Managerial incentives

<u>Relationship</u>	<p>Shareholder – Manager</p> <p>Most typical example of pay-for-performance and principal-agent relationship.</p> <p>Variant: Fund management (Fund’s shareholder – Fund manager)</p>
<u>Assumptions</u>	Moral hazard, adverse selection
<u>Benefit of PbC</u>	<p>Sharing of risk and profits for enabling alignment of goals</p> <p>There is evidence that “operating performance is positively related with foreign held shares and investment corporations held shares, indicating better investor protection from managerial opportunism” (Lambertides and Louca, 2008: 395).</p>

### 3.5.5 Public service outsourcing / Social Service

<u>Relationship</u>	Government/Public Agency – Private Service Provider
<u>Assumptions</u>	Moral hazard, adverse selection, Profit orientation (service provider) vs. social goal (government),
<u>Benefit of PbC</u>	<ul style="list-style-type: none"><li>• Output-based contracts help to align the Public agency’s social goal with the service provider’s profit orientation.</li><li>• An effective technique for holding welfare service programs accountable for the outcomes they promise ( )</li><li>• Performance based contracting in social welfare programs, has had positive effects on the overall progress of the delivery of the services.</li><li>• Improved contract efficiency over time</li><li>• Service providers have responded to these changes in contracting and prioritized their efforts towards targeted performance goals</li></ul>
<u>Challenges</u>	<ul style="list-style-type: none"><li>• Human services are very difficult to quantify</li><li>• Gatekeeper dilemma (see next example, call-centers)</li><li>• Deficiencies in contract management may lead to performance / contracts failures</li></ul>

(References: Hannah et al., 2010; Heinrich and Choi, 2007)

### 3.5.6 Call-centers and referrals

<u>Relationship</u>	Customer centre (employer) – Gatekeeper (employee) Examples of industries: health care, IT support
<u>Assumptions</u>	Trade-off between efficiency and effectiveness of service. The <i>gatekeeper</i> must choose between “pass along”, i.e referring the call to a specialist, which is expensive, or “treat” the call, thus protecting the specialist (controlling costs), but at risk of not solving (correctly) the problem.
<u>Benefit of PbC</u>	Compensation system proposed is “paying for solves” (in addition to a fixed wage), based on 3 variable: <ol style="list-style-type: none"><li>1. Number of calls answered (maximization)</li><li>2. Number of resolution of complaints (maximization)</li><li>3. Number of referrals (minimization)</li></ol>

(References: Shumsky & Pinker, 2003)

### 3.5.7 Public service outsourcing / Transport

<u>Relationship</u>	Government/Public Agency – Transport Service Provider
<u>Assumptions</u>	Moral hazard, Adverse selection, Profit orientation (service provider) vs. social goal (government)
<u>Benefit of PbC</u>	<ul style="list-style-type: none"><li>• For aligning the social objective of the public agency with the service provider’s profit orientation.</li><li>• The operator knows better than the contractor how to perform the work, so PbC give him/her more freedom of action</li><li>• Less monitoring costs for the agency</li><li>• PbC as a practical alternative to competitive tendering</li><li>• Suggested incentives include:<ul style="list-style-type: none"><li>– <i>Incentives for train-km and seat-km internalizing existing passengers’ benefits into a financial criteria;</i></li></ul></li></ul>

– *Passenger incentives internalizing the external costs of road congestion*

- To avoid large operating profits (enabled by the incentive scheme), the operator must pay a lump sum fee for the right to operate.
- Additional bonus/malus are suggested for criteria not-subsidized, like QoS, with a threat of tendering if quality falls below a certain level

Challenges

1. Number of passengers not controllable by the transport operator, therefore no penalty should be based on a reduced passenger numbers.

(References: Hensher & Houghton, 2004; Hensher & Stanley, 2003,2008; Fearnley et al., 2004)

**3.5.8 Supply Chain Contracts, 3PL, B2B**

Transaction Shipper (customer, supplier) – Logistics Provider

Assumptions Distinct attitude towards risk, profit orientation,  
Traditional supply-chain contracts include:

- Buyback contract: leftovers returned to the supplier at a fraction of purchase price
- Revenue sharing contract: a fraction of the revenue is shared at the end
- Quantity flexibility contract: possibility to adjust orders over time

Benefit of PbC

- Performance-based Logistics focus more on contracting a performance, rather than a task
- Sharing of risk and profits for enabling alignment of goals
- Motivate all the parties to be a part of the entire supply chain for sharing risks and rewards
- Identifying an optimal quantity may be useful for defining contract, not the other way around. Risks can be reduced by defining optimal order quantity
- Performance measures include: expected profit, average sales, unit shorts, leftover inventory, revenues realized, salvage realized, goodwill realized, and flexibility

(References: Wang, et al., 2011; Arshinder et al., 2009)

**3.5.9 Maintenance, Repair and Operation (MRO) service outsourcing**

Transaction Customer – MRO service provider (either the manufacturer, equipment supplier or an independent service provider)

Example of equipment: office equipment, airplane engines and brakes, hospital equipment, information technology, and production machines

Assumptions Moral hazard, adverse selection, Profit orientation (service provider) vs. social goal (government)  
Traditional MRO contracts include:

- MRO service level agreement with or without spare-parts costs
- Cost-plus contract (reimbursement of spares + profit percentage)

Benefit of PbC

- Performance based contracting based on product reliability in major manufacturer air craft engines has shown positive results in terms of service performance.
- Performance-specific Maintenance Contract (PSMC) enable paying for an outcome, not an activity
- Switch from an equipment provider to a “performance provider”
- Example of Rolls Royce’s Power-by-the-hour, which links the payment for engine MRO services to the availability of the engine (in hours) rather than reimbursing for spares and repairs
- Three approaches to payment structure of PbC in manufacturing

	<ul style="list-style-type: none"> <li>- Delivered performance (pay on availability, with bonus for uptime higher than target level)</li> <li>- Actual demand performance (pay per unit, pay on production, pay per use)</li> <li>- Customer's economic results as a consequence of using the machinery or equipment</li> </ul>
<u>Challenges</u>	<ul style="list-style-type: none"> <li>• When multiple contractors, individual incentive contracts must contribute to maximizing the overall profit</li> </ul>

(References: Tarakci et al., 2006; Damjanovic & Zhang, 2008; Hypko, et al., 2010; Ng et al., 2010; Kumar et al., 2006)

### 3.5.10 R&D outsourcing

<u>Relationship</u>	Production firm (Client) – R&D company
<u>Assumptions</u>	<ul style="list-style-type: none"> <li>• Moral hazard, adverse selection</li> <li>• Profit orientation (service provider) vs. social goal (government)</li> <li>• Higher risks of leakage of trade secrets when outsourcing R&amp;D activity under a lump sum contract</li> </ul>
<u>Benefit of PbC</u>	<ul style="list-style-type: none"> <li>• Revenue-sharing contract may mitigate information leakage</li> <li>• Intellectual property protection encourages more R&amp;D outsourcing</li> </ul>
<u>Challenges</u>	<ul style="list-style-type: none"> <li>• Complexity of the contract increased by the intangibility of ideas and information.</li> <li>• Finding the trade-off between the cost of information leakage and the benefit from innovation specialization</li> </ul>

(References: Lai & Riezman, 2009)

### 3.5.11 Software Development Outsourcing

<u>Relationship</u>	Client – Software development company
<u>Assumptions</u>	Adverse selection, moral hazard
<u>Benefit of PbC</u>	<ul style="list-style-type: none"> <li>• Aligning the remuneration of the offshore supplier on the performance of the software rather than on time and resources spent will have a direct effect on the quality provided</li> </ul>

(References: Gopal & Koka, 2010; Osei-Bryson & Ngwenyama, 2006)

### 3.5.12 Outsourcing of Marketing services

<u>Relationship</u>	Case of “Agency triad”: <ul style="list-style-type: none"> <li>- Two principals: Marketing and Supply Management departments</li> <li>- One agent: the marketing service company</li> </ul>
<u>Assumptions</u>	<ul style="list-style-type: none"> <li>• Increasing involvement of the purchasing department in purchasing of complex services by other departments</li> <li>• Problem of internal goal conflicts: Marketing department focused on quality, purchasing department focused on costs.</li> <li>• Adverse selection and moral hazard</li> </ul>
<u>Benefit of PbC</u>	<ul style="list-style-type: none"> <li>• Enable the alignment of goals among the three parties</li> <li>• Joint of definition of performance metrics enable better measurement of results, thus better contracts.</li> </ul>
<u>Challenges</u>	<ul style="list-style-type: none"> <li>• Marketing is a complex service because high heterogeneity and intangibility of outcomes, interdependencies among elements of performance and no real knowledge of budget and value for money</li> </ul>

### 3.5.13 Computer network service – SLA

<u>Relationship</u>	Network user - Network service provider
<u>Assumptions</u>	
<u>Benefit of PbC</u>	<ul style="list-style-type: none"><li>• SLA typically used in internet services; network services</li><li>• Rather than monitoring the networks, used of QoS parameters or directly detecting SLA violations is more efficient</li></ul>

(References: Serral-Garcia et al., 2010; D'Antonio et al., 2004)

### 3.5.14 Professional Services

<u>Relationship</u>	Client firm – Consulting firm
<u>Assumptions</u>	Characteristics of contractual relationships management consulting & clients <ul style="list-style-type: none"><li>- High degree of transactional uncertainty (not a ready-made product)</li><li>- Double moral hazard, due to high integrativity, i.e. customer involvement in service creation</li></ul>
<u>Benefit of PbC</u>	<ul style="list-style-type: none"><li>• Contracts can be essential for the creation of incentives to control the behavior of those involved in the service encounter</li><li>• Output measurement is very important, but in case of high integrativity, it may be unwise to base the remuneration on output</li></ul>
<u>Challenges</u>	<ul style="list-style-type: none"><li>• Intangible service =&gt; difficult to define objective measures</li><li>• The risk of double-moral hazard suggests that it might be optimal not to tie the remuneration of a service provider to actual performance</li><li>• When high level of interactivity, output sharing can weaken the incentives for both parties</li><li>• In long term business relationships, trust and reputation can mitigate potential opportunistic behavior</li><li>• Behavioral contract can be used effectively when behavior is observable, but not verifiable (basis for trust and reputation)</li></ul>

(References: Homburg & Stebel, 2009)

## 4 PbC for Ship Management

### 4.1 Introduction to PBC and Technical Ship Management

It is believed that Performance based contracts, or Service Level agreements, will increase in use as KPIs become more widely accepted, understood, utilized and standardized.

The use of Key performance indicators can be internal and external, hence external companies may use them to evaluate third party before business contracts or agreements are made.

In principle, everything can be contractually regulated, so the question is mostly how it can be done in the best possible way. By linking the performance contract to measurable and transparent figures, it is easier to determine if the goals are achieved, and to identify what works well and less well. The main challenge related to PbC for Ship Management is the lack of standardized measurement of performance in the shipping industry, which has led to a situation where a lot of companies are defining, measuring and reporting performance information differently. This results in too many KPIs, which in turn has increased the risk for confusion and mistakes<sup>10</sup>. There are a large number of information systems, along with a ‘spread-sheet’ culture where data is collected manually, which increase the risk for mistakes. The lack of consistency of performance indicators (PIs) and data collection processes may also have an impact on overall performance. It is thus a hard task to compare performance between two companies. Further, the focus on quality improvement is not possible due to lack of aggregated measurements and benchmarking to the performance of the industry.

If a contract based on performance is to work, the parties must agree on how to measure such performance. The Shipping KPI project is intended to result in just such a standard that can be used together with e.g. SHIPMAN 98/09.

### 4.2 Performance for whom, by whom?

Before investigating the applicability of PbC to Ship Management, it is necessary to specify the context in which such PbC is to be used. To do this we assume that at the extreme there are two schools each of ship owners and managers:

Ship owners	Ship managers
Assets players	3 <sup>rd</sup> party
Long term operators	Integrated or “In-House”

The Owner-Manager relationship resulting from the combination of these different types of ship owners and ship managers are summarized in the matrix in Figure 4.

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<sup>10</sup> This may be due to, among others, the fact that ships do not have broadband internet connections, and transfer of data from the vessels to the shore office is often done by e-mail (either word documents or excel spreadsheets). There are of course some high-tech ships with state-of-the-art ICT for ship/shore communications and data logging, but these are not common. This however is changing and more data is slowly becoming available from onboard electronic sources.



**Figure 4: Distinct types of business relationships between ship owners and ship managers**

The combination in the lower left quadrant is non-applicable, as an integrated ship management service supposes that the ship owner is engaged in long-term ship operations and not only an asset player. The following sub-sections give a brief overview of the other relationships.

#### 4.2.1 Managerial Contract

The type of contract governing this relationship is a managerial contract and may use performance indicators as a monitoring system. PbC can be applied, but the risk and profit sharing are different from that among two business partners. Besides, it can be assumed that when ship management conducted in-house, goals will be more aligned than in case of outsourcing, and behavior is much more verifiable.

#### 4.2.2 Outsourcing Contract

This is the type of market relationship that will be governed by a business contract. In this situation, the ship owner and the manager are two separated companies, and the ship manager is bound by a contract, and is expected to act as the owner is expecting. This situation is ideal for contracts using incentives for aligning the goals of the manager with those of the owner.

#### 4.2.3 Single-goal Contract

This relationship is also an outsourcing type of contract, but here the nature of the ship owner (asset player) is such that the only goal sought is profit, and it can be assumed less goal conflict is this type of contract (the ship manager also seeking profit).

### 4.3 Conceptual application of PbC for Ship management

We believe that PbC contracts most likely will be used between owners and managers with long-term horizon (upper right box). However, other relationships may also benefit from using PbC, but they will not be treated in the present demonstration.

When it comes to specific areas on which PbC should focus, long-term owner areas of interest (priorities) could include, for instance, the following:

- Safety
- Public opinion
- Crew treatment
- Environmental
- CSR
- Operational expenses
- Asset (final value)
- Regulatory deficiencies

The present demonstration will attempt to test the feasibility of PbC between the ship owner and ship manager, based on the above areas of owner's interest.

Based on the review of theories, concepts and principles, a set of main implications (challenges, dilemma, argumentation) for PbC in Ship Management are summarized in the table on the following pages.

Theoretical background	What does it mean for Ship Management
<b>Transaction description</b>	
<b>Types of transactions:</b> market, hybrid or firm?	For ship management, this means choosing between outsourcing all or a part of management services (to 3P ship manager) (market), in sourcing (in-house, subsidiary) (hybrid), or completely integrated ship management services (hierarchy).
<b>Asset specificity:</b> transaction-specific investments	For ship owners and ship management, this corresponds to the extent to which a party is "tied in" in a two-way or multiple-way business relationship. For example. In certain worldwide trades, such as reefer and car carrier trades, the governance structure could be defined as hierarchical due to high asset specificity and high degree of specialization.
<b>Uncertainty:</b> risk of the transaction	For ship owners and ship management, this corresponds to uncertain futures. The future may bring prosperity, bankruptcy, or some intermediate outcome, and the future is only partly controlled by organization members. Environmental effects such as government regulation, emergence of new competitors, Financial crises and technical innovation can affect outcomes.
<b>Frequency</b> of transaction	In ship management the frequency is 24/7 as the ship manager is responsible for technical management of the vessel at all times
<b>Outsourcing vs. in-sourcing</b> decision?	Ship management has low uncertainty (business is known and regular), high frequency and low asset specificity => Contracting is appropriate
<b>Principal-Agent relationship</b>	Ship Owner – Ship Manager
<b>Challenges related to contractual relationships</b>	
<b>Self-interest is generally assumed in business relations</b>	A priori, the 3rd party ship manager is not primarily interested in the owner's concerns as long as the management fee is paid. Similarly, the owner is not interested in the ship manager's profit or even losses, as long as expected level of service is accomplished.
<b>Goal congruence is generally a prerequisite for contracts</b>	A Performance Based Contract will create incentives for the ship manager to align the ship owner's goals and areas of interest.
<b>Moral hazard / opportunism</b> is generally assumed in business relations	Opportunism does exist in ship management
<b>Information asymmetry</b> refers to <b>when one party has information that the other party does not.</b>	The type of important information that only the ship owner or the ship manager possess at the time of the contract negotiation can be related to own capabilities, resources, own motivation/agenda, , vessel's current status and history,
<b>Risk aversion</b> refers to low tolerance for risk	It is argued that ship managers are not affected as strongly as ship owners in period of economic downturn. Technically, while ship owners struggle will lay-outs, the number of ships managed by the manager can remain constant. Some ship managers appear more willing to bear more of the risks with the expectation of higher profits. Others are becoming conscious of the risks posed by their clients and will only accept business if the feel the client has a sufficiently low risk profile. This in part may be due to difficulties in recruiting good quality crews, and wanting to ensure their operations are sustainable. Ship owners, on the other side, appear hesitant to share business-related risks, but the real reason is because they are still reluctant to sharing their profits with third parties.

<b>Adverse selection</b> means that the wrong contractor is likely to be selected due to information asymmetry	Adverse selection is an issue in ship management. It is difficult for a ship owner to assess a ship manager with whom they have no previous history, although there are databases where owners can check some statistics on the Ship Manager's performance, such as PSC detentions, collisions, etc. Besides, the type of ship, its age, technical profile, operational profile and flag are all elements that call for specific ship management qualifications and must be taken into account for finding an appropriate ship manager.
<b>Behavior vs. Outcome based contract?</b> (propositions from Eisenhardt, 1989)	
Prop 1: Outcome-based contracts align the interests of the agent and principal	If a ship owner manages to clearly stipulate requirements in terms of performance, the outcome-based contract will enable the alignment of manager's goals to the owner's. Challenges include goal clarity and performance measurement. The owner would a priori be more interested in outcome-based contracts (in case of non-verifiability of the manager's actions).
Prop 2: Verifying behavior makes the agent behave in the interest of the principal	The ship manager will be more likely to act in the interest of the owner when its working processes and tasks can be verified by the owner. Performance standards measuring actions rather than results will be useful for behavior-based contracts.
Prop 3: Information systems make the agent behave in the interest of the principal	Similarly to the above proposition, the more information the ship owner has for verification of how the manager is working, the more useful behavior-based contracts will be. In case of lack of behavior based information for monitoring purposes, outcomes-based contracts are preferable.
Prop 4: Outcome uncertainty favors behavior based contracts	Outcome uncertainty like operational issues, cargo volumes, and trade related issues is low-to-medium, and therefore outcome-based contracts are quite suitable for ship management outsourcing.
Prop 5: The risk aversion of the agent favors behavior based contract	For outcome-based contracts to work successfully, the ship manager must accept to take on additional risk, related to how well (s)he will perform given the market conditions, in expectation of receiving a share of the profit realized. The risk aversion of the ship management may be negatively related to the firm size or diversification of operations.
Prop 6: The risk aversion of the principal favors outcome based contract	If a ship owner is particularly risk averse, (s)he will prefer to transfer some of this risk on to the ship manager, thus preferring outcome-based contract.
Prop 7: Goal conflict between principal and agent favors outcome-based contract	For ship owners and ship managers, this means that outcome-based contracts are useful for overcoming the goal conflict (related to technical management, crew management and commercial management), by creating incentives for the agent to act in the interest of the principal.
Prop 8: Task programmability favors behavior based contract	Programmability is about how easy it is to define or describe a work. With respect to ship management, the programmability of the task is low as there are a wide variety of value propositions and business models. This favors the use of outcome-based contract.
Prop 8: Outcome measurability favors outcome based contract	Measurability relates to how easy or practical it is to measure the outcome of a task. In ship management, the outcome is complex, but with an established and agreed performance measuring system, like Shipping KPI, this is achievable. Nonetheless, without such a system, the measurability of the task will be difficult and subject to moral hazard from the part of the manager.
Prop 9: The length of the agency relationship favors behavior based contract	The length of the relationship between the parties influences the information asymmetry and trust between the parties. Longer-term relationships favor behavior-based contracts. This must be taking into account when

	designing a PbC system, but does not mean that PbC are not suitable for long term relationships. It is likely that a long-term PbC contract is more beneficial to the manager than a short term contract, since it makes it easier to optimize performance (over time) and maximizing remuneration. Similarly, a long-term contract may be more beneficial for the ship owner since it will result in improved performance (over time).
<b>Challenges related to Performance Measurement</b>	
Incentive-based contracts <b>may</b> align owners and managers' interests, but for the contract to be useful, payoffs must be linked to the performance.	Ship management presents some tasks for which performance is hard to determine and PbC will not be successful in aligning ship owner's and manager's interest. One example is crew planning, for which behavior based contract is better suited.
<b>Value of risk:</b> Incentives and rewards are said to be enough for outweighing the additional risk taken by the agent; this calls for robust and useful performance measurement	Incentives must be defined based on how much risk the ship manager is willing to take on with the expectancy of higher future benefits
<b>Utility functions</b>	Defining the utility function of ship owners would help determining how much of profit can be shared.
<b>Challenges related to Multiple-tasks contracts</b>	
<b>Effort substitution / Allocative efficiency:</b> in multi-task contracts, the agent's cost-benefit perspective may affect certain tasks negatively	The ship manager may put more efforts on certain tasks that are more profitable and which outcome is easy to measure. For example, in the short term, for a same level of expected remuneration, a manager would prefer to put more effort on crew planning (less investment) rather than crew training, whereas in a long term approach, crew training would contribute to creating a more sustainable crew management.
<b>Efficiency-challenges: trade-off between cost efficiency and uniform performance on multiple tasks</b>	Some tasks might "cost" more than other for achieving the required level of performance. For example, corrosion fighting can be limited to painting the vessel, which does not require high costs, or it can be done through a more corrosion-preventive approach, including sandblasting and/or grinding, which require much higher costs. It is importance that the incentive is linked to the marginal costs of the ship manager, in order to ensure a uniform level of performance on each task.
<b>Single or multiple payment (reward/penalty)</b>	Both alternatives might work, given the rather clear separation between the operational, technical and crew management elements of ship management. However, single payment seems more appropriate in order to hinder the manager to choose the tasks one which to put more efforts than others due to a higher expected profit. Please see section X for further explanations.
<b>Interdependency of measurements:</b> when the measurement of one task is affected by the performance on another task	Some incentives may influence several tasks simultaneously. One needs to make sure that whatever incentive one selects has the intended effect on all these tasks. As an example, using only budgetary performance as a measurement can easily lead to shortcuts in other tasks to save expenses.
<b>"All or nothing monitor":</b> Rewarding the overall outcome is more efficient than paying for piecemeal actions; but in case of large asymmetry among tasks, it seems better to use monitoring.	It is suggested no mix of behavioral- and outcome-based contracts. The proposed PbC for ship management should be based on KPIs only, and not subjective evaluation of the ship management company on vague criteria like customer service.
<b>Low-powered incentive contract:</b> when the outcome of at least one task cannot be observed or measured, it is suggested to modify the performance measure to	It is recommended not to establish PbC in which some tasks' outcome are too difficult to measure. For example, tasks requiring self reporting might be neglected by the manager to the benefit of tasks that are easier to measures, and for which risk of penalty is higher. An alternative can be to avoid linking the payment directly to

mitigate the incentives to work harder on well-measured tasks	individual task performance.
<b>Revelation and Self-selection principles:</b> <i>proposing a 'from the menu' set of PbC can help getting access to the right people for the right job; help dealing with hidden agenda, allocative efficiency etc.</i>	The higher the specificity of expected performance, the easier it will be to find the right ship manager (most qualified). Ship managers will themselves assess their suitability for the assignment. However, this creates dilemma like one between selecting non-experienced and experienced personnel (for securing higher performance).
<b>Challenges related to Long-term/Repeated contracts</b>	
<b>Dynamic Moral hazard:</b> long-term contracts can tempt the agent to “choose when to work”; this can be avoided by using controlling both individual and cumulative outcomes	On one side, long term contracts between ship owners and managers enable the building of trust, and give possibility to improve performance over time (learning curve). On the other side, repeated contracts may tempt the manager to anticipate profit and deliver irregular performance. Performance measurement should take into account both annual results and cumulated results over several periods.
<b>Trust:</b> when close relationships may offset the incentive-mechanism, it is suggested for the principal to keep the agent at ‘arm’s length’ and focus primarily on condition for payment and future contract allocation	It is argued that the length of the relationship favors behavior based contracts. Although trust is seen as both a driver and consequence of long term relationships, it is suggest that PbC will work best if the owner focuses primarily on performance measures and not be too open for adjustments.
<b>Co-creation / integrativity:</b> involvement of the client in the value creation; shared output gives weak incentives in case of high integrativity	If the ship manager feels that the performance depends also directly on the ship owner (e.g. ship technical conditions), (s)he may be reluctant to share risk. A prudent ship manager would have inspected the vessel, and agreed on the scope and costs to upgrade as required to reach an acceptable level of performance.

**Table 4: Theoretical assumptions and challenges related to PbC and signification for ship management.**

#### **4.4 Learning points from other sectors and types of relationships**

The following table presents a summary of the main aspects of the use of PbC in various sectors, based on the above review, and their significance for Ship Management. The first column shows 11 selected sectors or type of contractual relationships for which PbC have been used; the second column presents the main elements of the contractual relationship that are believed to be relevant for / comparable with Ship Management; the third column presents the main learning points from these other sectors for the application of PbC to Ship Management.

Sectors / contractual relationships	Main aspects, benefits and challenges related to the use of PbC	Implications for application of PbC to Ship Management
<b>Labor Economics</b> (employer – employee)	<ul style="list-style-type: none"> <li>• Linear sharing of benefits may result in less effort (no optimal performance).</li> <li>• PbC to be used only if all tasks can be measured.</li> <li>• PbC as an effective way to find the right people (self-selection), by providing a clear list of goals to achieve.</li> <li>• Externally-determined performance standards are preferable (not defined based on previous performance)</li> </ul>	<ul style="list-style-type: none"> <li>• If benefits are shared between the owner and the manager, the manager may not be motivated to do his/her best, especially on those tasks which performance depends also on efforts from the ship owner.</li> <li>• The PbC part of the contract must be based only on tasks with measurable outcomes; behavior- and outcome-based contracts cannot not be mixed.</li> <li>• PbC is likely to facilitate the selection of appropriate ship managers, by focusing not on qualifications, but directly on expected results.</li> <li>• Externally defined performance measurements may be most appropriate, while target values and payments should be negotiated.</li> </ul>
<b>Managerial Incentives</b> (shareholder – manager)	PbC enabling sharing of financial risk and profits, thus goal alignment.	<ul style="list-style-type: none"> <li>• The ship managers are found keen to share risk with ship owners and suggest that outsourcing is beneficial to the owners of ships since they can focus on their core business of chartering, commercial operation of the vessel and maximize their return of investment.</li> <li>• Evidence from European maritime (Lambertides and Louca, 2008) industry shows that due to having the same safety and operational requirement of the fleet and sharing the common values in terms of environmental protection, retention of competent seafarers by paying due incentives etc , ship managers have developed good relationships with ship owners.</li> <li>• Alignment of goals can be further achieved through formal PbC, including both incentives and penalties.</li> </ul>
<b>Insurance</b> (insurer-insuree)	Sharing of cost & risk can help to reduce waste and fraud.	<ul style="list-style-type: none"> <li>• Cost and risk sharing between owner and manager can be an effective way to incentivize the manager to control costs, thus improving both's profit.</li> <li>• Cost sharing can also help to cope with eventual fraud related to reimbursement of operational costs.</li> </ul>
<b>Public service</b> (public agency – private service supplier)	<ul style="list-style-type: none"> <li>• Conflicts between social and economic goals =&gt; Not all aspects can be subject to incentives.</li> <li>• Performance based contracting in social welfare programs can be used to “make the agent care”</li> <li>• Targeted performance goals help the service provider designing the service according to the public agency's social objective.</li> </ul>	<ul style="list-style-type: none"> <li>• Ship management areas facing clear trade-off between quantifiable and qualitative goals include environmental performance and health and security,</li> <li>• Some aspects of performance are very difficult to quantify (e.g. reputation)</li> <li>• In Ship management Corporate Social Responsibility (CSR) is one of the key areas where ship management companies are working to develop strategies to save environment and for a better public profile. This can be sustained by using PbC to develop CSR as a core competency, with various KPIs within ship management that relates directly or indirectly towards environment and social goals.</li> </ul>

	<ul style="list-style-type: none"> <li>Contract management and performance is crucial for ensuring performance according to the defined goals.</li> </ul>	
<b>Call-centers</b> (customer center – gatekeeper)	Trade-off between treating the demand at lower cost but risk of wrong treatment and passing-on to a specialist, at higher costs, but higher expected results.	A similar problem for PbC in Ship Management can be related to efficiency of operations and the trade-off faced by managers between efficient actions (less costly but risky, such as quick reparations of technical incidents),(,) and thorough actions (costly but safe, such as calling off-hire for reparation) PbC can help dealing with this problem by offering profit sharing depending on both costs savings achieved, but also on whether the other performance targets are reached.
<b>MRO</b> (customer – manufacturer/Service supplier)	Equipments suppliers become performance providers under a PbC. There are 3 approaches to payment structure: <ul style="list-style-type: none"> <li>– Pay on availability, with bonus for uptime higher than target level</li> <li>– Actual demand performance, pay per use</li> <li>– Customer’s economic results as a consequence of using the equipment</li> </ul>	The ship manager is responsible for assets owned by the ship owner. Attention is therefore drawn on vessel availability rather than on the particular equipment or crew assigned to the vessel or the way these are managed.
<b>R&amp;D outsourcing</b> (client – R&D agency)	Risk of information leakage, meaning that the agent may reuse knowledge/information for other clients or him/herself. PbC gives the agent strong incentive to work towards its clients’ performance and not inflicting him/her competition	There may be a risk that a ship manager works harder for a ship owner paying higher management fees / better conditions. Revenue-sharing can give an incentive to the ship manager not to cheat or perform poorly to the benefit of another ship owner.
<b>Product development</b> (customer –supplier)	Performance based contracts over time have become popular in industries like automobile, defense, information, technology aerospace and development of software.  Reference: <ul style="list-style-type: none"> <li>Switching from time/cost reimbursement to product performance-based payment is believed to affect positively the quality of the product being developed.</li> </ul>	<ul style="list-style-type: none"> <li>Under PbC, efficiency may lead to higher quality. Incentives that link the ship manager’s profit directly to the performance / Quality of Service motivate the ship manager to select the best resources in order to deliver the expected performance at relatively lesser costs (maybe higher investment costs, but less correction-related costs). For example, a ship manager will be motivated to invest in new equipment, new software, engaged the most qualified personnel in order to ensure the service is delivered as expected.</li> <li>A particular example of increase service quality and efficiency is the increased use of communication technology. As a service provider, ship managers have increased market penetration in existing markets with the product development of various software, thus revealing the major role that</li> </ul>

		technology has played for innovative ship management services.
<b>Marketing services</b> (marketing + purchasing Dept – marketing service agency)	Marketing are complex services characterized by high intangibility and a value-for-money difficult to quantify. They are an example of “agency triad”, in which the agent, the marketing service company, is facing two principals, the marketing and the purchasing departments of its client.	In addition it should be added that the disadvantages the owners has through "subjective" Performance Indicators, can be an advantage if the ship is chartered out. The latter will naturally depend on the ship / technical manager performance and high KPI figures will then be a plus for owners, i.e. so that the ship-owner’s and managers' interests coincide to the charterer. Charterer (which comes in the ship owner’s location) will be able to take advantage of the above proposal in the same way as the owner. In addition, will the owner in many cases make a real and objective review of the technical manager contract compliance, which also the charterer will benefit of? The charterer must be given the opportunity for auditing the base data in the same way as the owner.
<b>Professional services</b> (client – consultant)	Services characterized by: <ul style="list-style-type: none"> <li>• High uncertainty (knowledge-based services)</li> <li>• Double-moral hazard due to high integrativity (participation of the client in the delivery of the service)</li> </ul> It is suggested no use of outcome based contract, because of the difficulty to measure performance and incentives to make efforts may be weakened when the profits shared also depend on the client’s performance.	<ul style="list-style-type: none"> <li>• Integrativity should be reduced as much as possible, either by delegating more to the ship manager, or by basing the PbC only on tasks in which the ship owner has no involvement.</li> <li>• PbC must be based on well measurable outcomes, not depending on the ship owner’s performance.</li> <li>• Trust and long-term relationships may be affected if all aspects of the service become subject to performance measurement.</li> </ul>

**Table 5: Learning points from use of PbC in different sectors / types of contractual relationships and signification for PbC for ship management**

## 4.5 PbC for Ship Management – Pros & Cons

*Why would a ship owner share benefits with the ship manager?*

*Why would a ship manager take on more risk than necessary?*

At first sight, PbC may encounter resistance and skepticism, but in light of the Pros and Cons overview made for PbC in other sectors, the following a priori advantages and drawbacks can be argued regarding PbC for ship management.

	PROS/ADVANTAGES (over SHIPMAN)	CONS/DRAWBACKS
Ship Owners	<ul style="list-style-type: none"> <li>• It is an advantage for large ship owners who want to benchmark the cost and efficiency of their ship managers, whether in house or 3<sup>rd</sup> party management.</li> <li>• PBC based on measurable KPIs can help the owners select the right ship managers (clear goals and budget).</li> <li>• Sharing of risk and responsibility</li> <li>• In case of socio-environmental incident, throwing of responsibility on the manager can be more convenient with PbC.</li> <li>• Sharing common values in terms of environment protection, retention of competent seafarers and safety and operations requirements, PBC will help developing long term strong relationships.</li> <li>• PbC create an additional (economic) incentive for the manager to optimize performance, thus deliver higher quality for money.</li> <li>• Ship managers can no longer act on behalf of a rival fleet owner, because payment depends on performance.</li> </ul>	<ul style="list-style-type: none"> <li>• Owners relinquish some control over resources and operations. Some fear that this can lead to managers dictating the owners.</li> <li>• Risk of hidden information and false reporting from manager.</li> <li>• Risk of reduced transparency as focus is on results and not on process</li> <li>• More qualitative goals may be neglected in the pool of quantitative, tangible measurements</li> <li>• PbC is not a guarantee against cheating.</li> <li>• Ship Owners do not want to share risks, mostly because they do not want to share profits</li> <li>• Ship manager may refuse contracts on deteriorated / old vessels</li> <li>• Ship managers may ignore some task to the benefit of more profitable ones.</li> </ul>
Ship Managers	<ul style="list-style-type: none"> <li>• Possibility of increased remuneration based on performance</li> <li>• Managers do not need to justify actions to principals anymore; hence owners do not have control over their key policy issues.</li> <li>• Management may assist in dealing with liabilities' and may be seen as an advantage by financiers and insurers.</li> <li>• Ship managers can communicate on own performance and use results from PbC to improve reputation.</li> <li>• PBC can enable "good" ship managers to gain competitive advantage.</li> <li>• Risk sharing can be beneficial for developing long term strategies with owners</li> </ul>	<ul style="list-style-type: none"> <li>• Some characters might not be willing to take on more risk.</li> <li>• However, they may have a negative effect due to driving the operations through KPIs/Numbers, to meet an overall target which could sometimes jeopardize safety and increase risks.</li> </ul>

**Table 6: Summary of pros and cons of PbC from the perspective of the ship owner and ship manager**

One important challenge related to performance management is *reporting*. A recent study on reporting practices in merchant shipping highlighted that only 30% of accidents experienced were reported (Psarros et al., 2010; Oltedal & McArthur, 2011), and reporting is believed to be worse in dry cargo than in the tanker segment. Lack of sufficient reporting will also influence the quality of any measurements used in performance management, e.g., as KPIs.

Reasons for low reporting frequency include (Oltedal & McArthur, 2011; Espin et al., 2007; Van der Schaaf, 2004):

- Efficiency is given more importance than safety: efficiency can often justify the violation of safety rules.
- Low attention to safety from shore personnel
- Fear of blame and punishment.
- Lack of confidentiality
- Time constraints and practical reasons.
- Reporting is seen as useless.
- Lack of post-reporting feedback; no reward for reporting
- Risk acceptance: macho attitude; incidents are underestimated

Reporting frequency can be increased through (Oltedal & McArthur, 2011):

- enhanced safety related training
- a trusting and open relationship among the crew
- safety oriented ship management
- performance of pro-active risk identification activities
- feedback on reported events

## **5 Mapping of Shipping KPIs to Performance Based Contracts in Ship Management**

This section depicts how the KPIs from Shipping KPI may be applied in Performance Based Contracting.

First a mapping between Shipping KPIs and sections in SHIPMAN (the standard contract between a ship manager and a ship owner) is presented. This is done to show how an addendum to the SHIPMAN contract can be used to define required KPIs, target KPI Values, bonus for performance above the target value (per KPI) and penalties for performance below the target value (per KPI). In SHIPMAN the contractual obligations between a ship manager and the ship owner are defined and the proposed addendum will be a specification of these obligations in light of performance.

Next a mapping between Shipping KPI and the generic processes defined in Flagship is presented. This is done to show how the KPIs from the proposed addendum to SHIPMAN will be useful also for an eventual improvement process undertaken by the ship manager in cases where performance targets are not met.

Then a mapping between Shipping KPI and ship owner's areas of interest is presented. This will serve as input to the issue of convincing ship owners that performance based contracting will add value also to their business.

Finally, on basis of the three mappings mentioned above, the final list of Shipping KPIs which will be used in the analysis is presented.

This document should be read in light of the proposed process for implementation of Performance Based Contracts in ship management (section 6.1.1).

Please visit <http://www.shipping-kpi.com> for detailed descriptions and definitions of the Shipping KPIs and their related Performance Indicators.

### **5.1 Shipping KPIs not suited for performance based contracting in their original form**

Please note that some of the Shipping KPIs may at first glance seem relevant for the proposed mappings but when looking at the detailed definition of the KPIs or at the detailed description of how (and when) the related Performance Indicators (the measurements used to calculate the KPI Value) should be collected/reported it is obvious that some of these KPIs are not directly applicable. Below we present the different challenges identified and examples of KPIs which have been deemed as unsuitable:

- *Shipping KPIs not under the sole control of the ship manager:*

The Shipping KPIs related to emissions would at first glance fit the SHIPMAN section Technical Management (as emissions is to a certain extent dependent on the maintenance of the hull and engine of a vessel) but when looking at the KPI descriptions, these KPIs are calculated by dividing the emitted mass of CO<sub>2</sub>/NO<sub>x</sub>/SO<sub>x</sub> by the vessel’s transport work. The vessel’s transport work is a product of the commercial operator’s ability to utilize the vessel (ton-mile) and as the KPI Values of these KPIs are so dependent on issues outside the ship manager’s responsibility they are unsuited in the proposed SHIPMAN addendum.

- *Shipping KPIs not expressing the ship manager’s performance for a specific vessel:*

The Performance Indicators relevant for the Shipping KPIs “Officer retention rate”; “Training days per officer” and “Cadets per vessel” are aggregated on a fleet level, meaning that the KPIs do not express the ship manager’s performance regarding a specific vessel but rather as an organization. This fact makes these KPIs unsuitable for the SHIPMAN addendum. The exception would be the situation where the owner has several vessels under one ship manager.

- *Shipping KPIs where the target value would be impossible to out perform:*

As no ship owner would accept a fire or explosion onboard the vessel, the Shipping KPI “Fire and explosion” would have a target value of zero. A ship manager would only most reluctantly accept KPIs where there is no chance for a bonus but a fair risk of penalty. This however is dependent on the agreed upon bonus/penalty regime. In cases where a single KPI is selected to calculate the bonus/penalty while the remaining KPIs are used to monitor/detect potential sub optimization the remaining KPIs may very well have target values which would be impossible to out perform (see section 6.1.1).

## 5.2 Mapping between Shipping KPIs and SHIPMAN

The table below depicts a mapping between sections in SHIPMAN and Shipping KPIs. For each section we present relevant KPIs from the Shipping KPI standard.

Please note that the table below only lists sections from SHIPMAN where we have identified relevant Shipping KPIs.

SHIPMAN 2009 sections	Relevant PBIs ( <i>ShipMan required measures</i> )	Relevant Shipping KPIs
4 Technical Management	<b>Technical Management</b>	Ballast water management Failure of critical equipment and systems Fire and Explosions Flawless PSC performance PSC deficiency ratio PSC detention Vessel availability Navigational incidents Cargo related incidents Releases of substances as def by MARPOL Annex 1-6 Contained spills

		Environmental deficiencies Navigational deficiencies Operational deficiencies Security deficiencies Passenger injury ratio Vetting deficiencies
5 Crew Management and Crew insurances	<b>Crew Management</b> <b>Crew insurances</b>	Lost time injury frequency Lost time sickness frequency Crew planning Officer experience rate Officer retention rate Health and safety deficiencies HR deficiencies Training days per officer
6 Commercial Management	<b>Commercial Management</b>	Budget Performance
20 Compliance with Laws & regulations		Ballast water management PSC deficiency ratio PSC detention Flawless PSC performance Releases of substances as def by MARPOL Annex 1-6 Conditions of class

**Table 7 Mapping between Shipping KPIs and SHIPMAN**

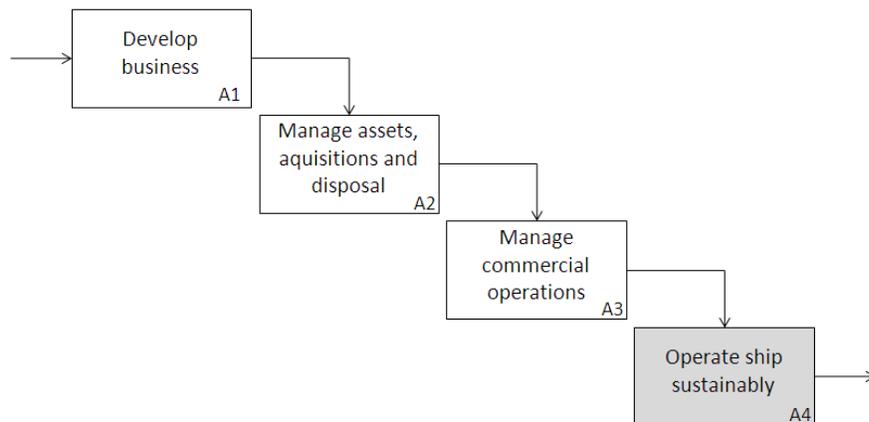
### **5.3 Mapping between Shipping KPIs and generic processes defined in Flagship**

Under the notion “You cannot manage what you don’t measure” we set out to map Shipping KPIs to the generic processes defined in Flagship. The rationale for doing this is twofold: 1) To see whether the Shipping KPIs are applicable to the generic processes defined in Flagship concerning result based management and 2) To see whether a ship manager involved in a performance based contract can use the generic processes from Flagship to improve the operation when under performing in light of the KPI target values defined in the proposed SHIPMAN addendum.

The Flagship model applies IDEF0 notation for process mapping and on top level four main processes are described. In the Shipping KPI project the main focus has been on describing performance related to Ship Management, or technical operation of vessels. This section will elaborate on how measurements defined in the Shipping KPI standard can be utilized to measure performance aspects of the “Operate ship sustainably” (A4) of the Flagship model.

The objective is to verify if the Shipping KPI measurement tool can paint a relevant performance picture of the processes of the Flagship model and thus be a foundation for developing performance-based contracts for ship management.

The illustrations used here are simplifications of the detailed process maps from Flagship. The management function is within the “Operate ship sustainably” sub-process.



**Figure 5: Flagship top level processes**

“Operate ship sustainably” contains five sub processes of which three are found to have measures which fall into the area where Shipping KPI provides measures.

- *Provide Crew* is covered in through a series of measures related to recruit/retain crew and to training and experience of crew.
- *Run Ship* is covered with a series of indicators covering three main areas, Cargo handling, Sail Ship and Monitor Condition, more details to be given later.
- *Maintain and Repair Ship* is covered through dry docking planning and more generally through vessel availability.

Below we present the Shipping KPIs linked to each of the three sub processes under the main process Operate ship sustainably.

### 5.3.1 Provide Crew

The process shall provide the required number of crew with the correct qualifications for the vessel to perform its tasks according to statutory and contractual requirements. This process is decomposed into recruiting, assessing qualifications, training, assigning and familiarizing crew with vessel.

The proposed KPIs are measuring the following:

Process (Level 3)	KPIs	Aspects measured by the KPI
<b>Recruit</b>	Officer experience Rate	Measures the sailing experience of the crew and as such is a proxy of qualifications related to the corporate ISM system
	Officer Retention Rate	Measures the ability of the company to retain people, a complex measure affected by culture and market
<b>Training</b>	Training days per officer	Measures the training above statutory requirements and

		as such the commitment to continued education of officers
	Cadets per vessel	Measures number of cadets and as such the commitment to training new recruits
<b>Assigning crew</b>	Crew planning	Measures the ability to plan and schedule crew rotation correctly and as such has a potential indirect influence on safe operations

**Table 8 Mapping of Shipping KPIs to Flagship process: Provide Crew**

### 5.3.2 Run Ship

The process covers all the operational aspects of operating a vessel, preparing her for voyage, loading and discharging cargo and passengers, performing the actual sea voyage and monitoring the condition of the vessel. The process is decomposed into Make ship operable, plan voyage, load cargo, sail ship, monitor condition and discharge cargo.

*For simplicity we do not distinguish between cargo and passengers onboard even if the handling procedure is distinctly different.*

The proposed KPIs are measuring the following:

Process (Level 3)	KPIs	Aspects measured by the KPI
<b>Cargo handling</b>	Ballast water management violation	Ballast water violations is primarily an environmental measure, but it also reflects on the cargo handling as ballasting is often done in relation to cargo operation
	Cargo related incidents	Measures the ability to handle the cargo properly so that the consignee gets undamaged cargo
	Passenger injury ratio	This measures the accidents the passengers have, but reflects also on how well passengers are managed and catered for.
<b>Sail ship</b>	Navigational incidents	Measures the occurrences of navigational incidents and as such expresses the complex relation between operational water, culture, technical systems, knowledge and training.
	Fire and Explosions	Counts the occurrences and is an expression of safety culture, precaution investments, training and safety management. This is also influenced by type of operation.
	Releases of substances as defined by MARPOL Annex 1-6	This is an environmental indicator dealing with any environmental spill and emission. Again this reflects on the management and culture of the company.
	Officer Experience rate	Measures the sailing experience and is in the model an outcome from sailing the vessel.
<b>Monitor condition</b>	Flawless PSC performance	Is a positive measure and if PSC does not find any discrepancies, this is an indication of a vessel/crew and management system in good condition.
	Port State Control detention	Is a measure of the number of detentions derived from PSC inspections, this is an indication of a vessel/crew and management system in good condition.
	Port State Control deficiency	Is a measure of the number of deficiencies derived from PSC

	ratio	inspections over the total number of PSC inspections, this is an indication of a vessel/crew and management system in good condition.
	Navigational deficiencies	Some of the deficiencies are related to navigational equipment condition but also to training and competence of the crew. So the measure is complex in nature but exposes an operational condition of the ship/crew system.
	Vessel Availability	This measures the availability of the vessel, or indirectly the amount of off-hire. Some of the off-hire is related to technical reasons and as such this is a proxy for the maintenance condition of the vessel.
	Vetting deficiencies	The measures the customer's perception of the condition of the vessel and management system.
	Condition of class	Measures findings by class which have to be corrected but which do not make the vessel un-seaworthy. This is an early indicator about the condition of the vessel.
	Failure of critical equipment	This measures the failures on vital equipment and is an indicator of the condition or the handling of the equipment.
	Budget performance	Measures the manager's ability to adhere to agreed budget, and is related to overall corporate control.

**Table 9 Mapping of Shipping KPIs to Flagship Process: Run ship**

### 5.3.3 Maintain or repair ship

The process shall develop maintenance and report necessary findings to defined bodies. This process is decomposed into Planning, Procurement, In-service repair, Off-service repair and Reporting.

The proposed KPIs are measuring the following:

Process (Level 3)	KPIs	Aspects measured by the KPI
<b>Make Plan Maintain out of service</b>	Drydocking planning performance	This measures the ability to plan a drydocking and stick to the plan. This shows the ability to prepare maintenance in adequate detail to enable solid planning of drydocking.
<b>NA</b>	Vessel availability	This measures the availability of the vessel, or indirectly the amount of off-hire. Some of the off-hire is related to technical reasons and as such this is a proxy for the maintenance condition of the vessel.
<b>NA</b>	Failure of critical equipment	This measures the failure of critical equipment, and as the one above this also is a proxy for how well maintained the vessel equipment is.

**Table 10 Mapping of Shipping KPIs to Flagship Process: Maintain or repair ship**

There are three process steps not directly covered, but Procurement is probably the one with the most impact where there is no coverage. The reporting process is to a certain extent covered by the deficiency reporting as missing maintenance will occur as deficiencies in either vetting, PSC, or other external inspections.

## 5.4 Mapping between Shipping KPIs and Ship owners' areas of interest

As seen in the discussions concerning the concept of performance based contracting in shipping one of the major challenges is related to the added value a ship owner will get from introducing performance based contracting in the relationship with ship managers. Below we present a mapping of the Shipping KPIs to the ship owners' area of interest. We do this to prove that the ship owner will benefit from the ship manager's performance (represented by the KPI Values of the KPIs mentioned below) hereby justifying the bonus given to the ship manager for performing above the agreed target KPI Values.

There are two main types of ship owners and this has relevance for the identified areas of interest. An asset player mainly requires that the asset (vessel) is not deteriorating in value and that sufficient income is secured to cover the asset's (vessel's) OpEx and CapEx. An asset player will therefore not benefit as much from performance based contracting as the other type of ship owner: the Long term owner. The Long term owner will have a much wider range of areas of interest and it is these areas of interest we have depicted and mapped to Shipping KPIs in the table below. Our thesis is therefore that Performance Based Contracts most likely will be used between ship managers and ship owners with a long-term horizon.

The Long Term Owners' Areas of Interest (priorities)	Relevant Shipping KPIs
<b>Own reputation</b>	
<b>Safety</b>	Flawless Port State Control performance Lost Time Injury Frequency Health and Safety deficiencies
<b>Public opinion</b>	Ballast water management violations Releases of substances as def by MARPOL Annex 1-6 Navigational incidents
<b>Crew treatment/condition</b>	Lost Time Injury Frequency Crew planning HR deficiencies Officers experience rate
<b>Environmental</b>	Ballast water management violations Releases of substances as def by MARPOL Annex 1-6 Cargo related incidents
<b>CSR</b>	Ballast water management violations Releases of substances as def by MARPOL Annex 1-6 Lost Time Injury Frequency Crew planning Navigational incidents
<b>Operational Expenses</b>	Budget performance
<b>Asset (final) value</b>	
<b>Regulatory deficiencies</b>	Environmental deficiencies Navigational deficiencies Operational deficiencies Port state control detention Security deficiencies Health and Safety deficiencies

	HR deficiencies Flawless PSC performance Port state control deficiency ratio
<b>Asset technical condition</b>	Failure of critical equipment and systems
<b>Asset availability</b>	Vessel availability

**Table 11 Mapping of Shipping KPIs to Ship Owner's area of interest**

## **5.5 Shipping KPIs relevant for the Flagship demonstrator concerning Performance Based Contracting**

On basis of the three mappings shown above the following list of Shipping KPIs can be derived:

Shipping KPIs	Relevant for SHIPMAN addendum	Relevant for Flagship generic processes	Relevant for Ship owners' areas of interest	Comment
<b>Ballast water management</b>	Section 4: Technical Management Section 20: Compliance with law and regulations	A4.4 Run ship	Public opinion, CSR and Environment	
<b>Cargo related incidents</b>	Section 4: Technical Management	A4.4 Run ship	Environment	
<b>Conditions of class</b>	Section 20: Compliance with law and regulations	A4.4 Run ship		
<b>Contained spills</b>	Section 4: Technical Management			Oil majors will have an interest in this KPI
<b>Crew disciplinary frequency</b>			Public opinion	
<b>Crew planning</b>	Section 5: Crew Management and Crew Insurances	A4.2 Provide Crew	Crew treatment/condition, CSR	
<b>Budget performance</b>	Section 6: Commercial Management	A4.4 Run ship	Operational expenses	
<b>Drydocking planning performance</b>		A4.5 Maintain or repair ship		
<b>Environmental deficiencies</b>	Section 4: Technical Management		Regulatory deficiencies	
<b>Failure of critical equipment and systems</b>	Section 4: Technical Management	A4.4 Run ship A4.5 Maintain or repair ship	Asset technical condition	
<b>Fire and Explosions</b>	Section 4: Technical Management	A4.4 Run ship	Yes	No potential for out performance of the target value
<b>Flawless Port State Control Performance</b>	Section 4: Technical Management Section 20: Compliance with law and regulations	A4.4 Run ship	Safety, Regulatory deficiencies	
<b>Health and Safety deficiencies</b>	Section 5: Crew Management and Crew Insurances		Safety, Regulatory deficiencies	
<b>HR deficiencies</b>	Section 5: Crew Management and Crew Insurances		Crew treatment/condition, Regulatory deficiencies	
<b>Lost Time Injury Frequency</b>	Section 5: Crew Management and Crew Insurances		Safety, CSR and Crew treatment/condition	
<b>Lost Time Sickness Frequency</b>	Section 5: Crew Management and Crew Insurances		CSR and Crew treatment/condition	
<b>Navigational deficiencies</b>	Section 4: Technical Management	A4.4 Run ship	Regulatory deficiencies	
<b>Navigational incidents</b>	Section 4: Technical Management	A4.4 Run ship	Public opinion, CSR	

<b>Officer experience rate</b>	Section 5: Crew Management and Crew Insurances	A4.2 Provide Crew and A4.4 Run ship	Crew treatment/condition	Fleet specific KPI
<b>Officer retention rate</b>	Section 5: Crew Management and Crew Insurances	A4.2 Provide Crew		Fleet specific KPI
<b>Operational deficiencies</b>	Section 4: Technical Management		Regulatory deficiencies	
<b>Passenger injury ratio</b>	Section 4: Technical Management	A4.4 Run ship		
<b>Port State Control deficiency ratio</b>	Section 20: Compliance with law and regulations	A4.4 Run ship	Regulatory deficiencies	
<b>Port State Control detention</b>	Section 20: Compliance with law and regulations	A4.4 Run ship	Regulatory deficiencies	
<b>Releases of substances as defined by MARPOL Annex 1-6</b>	Section 4: Technical Management Section 20: Compliance with law and regulations	A4.4 Run ship	Public opinion, CSR and Environment	
<b>Security deficiencies</b>	Section 4: Technical Management		Regulatory deficiencies	
<b>Training days per officer</b>	Section 5: Crew Management and Crew Insurances	A4.2 Provide Crew		Fleet specific KPI
<b>Vessel availability</b>	Section 4: Technical Management	A4.4 Run ship A4.5 Maintain or repair ship	Asset availability	
<b>Vetting deficiencies</b>	Section 4: Technical Management	A4.4 Run ship	Regulatory deficiencies(?)	Only relevant for vessels eligible for vetting inspections
<b>CO2 efficiency</b>			Public opinion, CSR and Environment	KPI not under the sole control by the ship manager
<b>NOx efficiency</b>			Public opinion, CSR and Environment	KPI not under the sole control by the ship manager
<b>SOx efficiency</b>			Public opinion, CSR and Environment	KPI not under the sole control by the ship manager

**Table 12 Shipping KPIs relevant for the Flagship demonstration**

## 6 Process for Performance Based Contracts in ship management

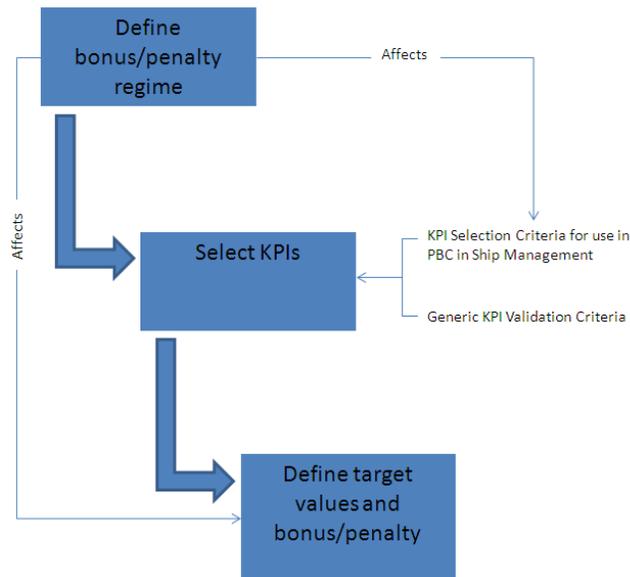
This section presents a three step process for the creation and implementation of a Performance Based Contract. The three steps are:

1. Creation of a Performance Based Contract
2. Auditing a Performance Based Contract
3. Validation of results

For each step the process behind creating a demonstrator for Flagship where the proposed process has been applied is presented. The aim of the demonstrator is to show the applicability of Shipping KPIs in Performance Based Contracts in ship management as well as explaining how the process for Performance Based Contracts in ship management should be followed in practice.

### 6.1 Creation of a Performance Based Contract

In the first step in the methodology the ship owner (principal) and the ship manager (agent) have to sit down and agree on three main issues namely: Definition of the bonus/penalty regime; selection of relevant KPIs; definition of target KPI values and bonus/penalty. The three main issues are interrelated as choices made regarding the bonus/penalty regime will affect the context in which the selection of KPIs is made (through the KPI selection criteria for use in PBC in ship management) as well as the definition of KPI target values and the bonus/penalty. The figure below depicts the interrelationship between the three main issues.



**Figure 6: Three main issues in creating the PBC**

Below we present all three issues separately. For each issue we will also present how these were dealt with in the creation of the demonstrator in Flagship.

### 6.1.1 Definition of the bonus/penalty regime

Before we go into details as to how a bonus/penalty regime should be defined we need to scrutinize on some of the key terms; namely what is a bonus and what is a penalty.

There are two main concepts within defining bonus and penalties. The first is a purely monetary approach where an agreed upon part of the management fee varies according to the performance of the ship manager. The second approach concerns the more qualitative issues in the relationship between the ship owner and the ship manager such as ability to re-negotiate contracts, extension of contracts (as a bonus) or early termination of contract (as a penalty). In both cases it is clear that a bonus is something seen as a benefit to the ship manager derived from quality performance, while a penalty is just the opposite<sup>11</sup>.

#### 6.1.1.1 How much is at stake?

Unless the financial or monetary aspect is kept entirely outside the equation there is a need to define the total amount at stake. How much money is the ship owner willing to risk, i.e. potentially having to pay extra if the ship manager performs well above the agreed upon target values? Similarly, how much money is the ship manager willing to risk, i.e. potentially accepting to deduct from the management fee if the performance is well below the agreed upon target values?

Basically we need to separate between the risk taken by the ship manager (max penalty) and the risk taken by the ship owner (max bonus). In cases where the risk is to be shared equally by both parties the ship manager would define the maximum risk he/she is able to take and the ship owner will meet this risk (meaning that the max penalty and the max bonus are the same amounts). In other cases the ship owner could be willing to take a greater risk by recognizing that the greater the ship manager's incentive is to deliver a high quality service the more the ship manager will strive towards deliver such a high quality service.

For the ship manager the risk/stake is found by identifying all fixed OPEX related to running the vessel (such as crew payments, spare parts, lube oil, maintenance and repairs, etc). The total sum of the fixed costs should not be part of the stake while the actual management fee would be the basis for the stake. An example will clarify:

The vessel in question is a Handymax Bulker (53600 DWAT). Typical daily average OPEX for such a vessel in 2011 is listed in the below table.

For the same vessel the management fee was about 393 USD per day in this case the stake would be based on how much of the 393 USD per day the ship manager is willing to risk (max penalty in case of under performance). For an even distribution of risk the ship owner would only have to

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<sup>11</sup> Whether a bonus to the ship manager is seen as a penalty for the ship owner (e.g. when the ship owner has to pay more) depends on the KPIs selected as part of the PBC. If the ship manager delivers high quality performance within the areas seen as important for the ship owner (verified through the selected KPIs) the negative side of paying more money is surpassed by the benefit of receiving a high quality service.

risk the same amount as the ship manager. There is no universal answer as to how big a share of the management fee the ship manager should be willing to risk as this is dependent on how much of the management fee the ship manager has planned to cover costs and how much of the management fee is planned to be profit to the ship manager.

<b>Fixed OPEX</b>	<b>USD per day</b>
Crew wages	2 087
Crew expenses	394
Victualling (ex.food)	161
Stores (incl. food)	245
Spare parts	245
Lube Oil	455
Maintenance and Repairs (M&R)	155
<b>TOTAL fixed OPEX</b>	<b>3 742</b>

**Table 13 Operational cost factors (Actual example, see footnote <sup>5</sup> at page 17)**

If the ship owner is willing to risk more than the ship manager there are two main ways of doing so. One way would be to define a share of the potential profit the ship owner gains from the vessel and another would be to define a share of positive deviation between the vessel's OPEX budget and the actual running costs and accruals (the ship manager spending less than budgeted). Again there is no universal answer as to how much the ship owner should risk.

How the agreed upon amounts are distributed as bonus/penalties will be discussed later in this section as this is dependent on which bonus/penalty regime that is chosen as basis for the PBC.

There are two main alternatives for bonus/penalty regimes both of which are presented below. Please note that a combination of the two main alternatives is possible but we have chosen in this report to focus on the two main alternatives.

#### **6.1.1.2 Bonus/penalty per KPI**

In this alternative each KPI is assigned a target value and a formula for calculating the monetary bonus or penalty depending on whether or not the KPI target value has been met. The basis for the distribution of potential bonus/penalty per KPI is the total amount at stake (see section 6.1.1.1) and the total bonus/penalty is calculated on basis of each KPI's bonus/penalty.

To be able to assign a specific bonus/penalty per KPI there is a need for weighting the KPIs. Weighting (prioritization) is the process of establishing the relative importance of the KPIs to each other. Weights should be applied to KPIs associated with those contract requirements which are deemed most important to the ship owner. Initially weighting should be done by assigning a percentage of the total amount at stake to each KPI. This may be left as a percentage or converted to a specific amount. The assignment of weights or specific amounts at the KPI level is recommended as it identifies to the ship manager how much importance the ship owner place on the achievement of those requirements. However, at the time the weights are assigned there

must be some certainty that the relative importance of the KPI will not change during the performance period.

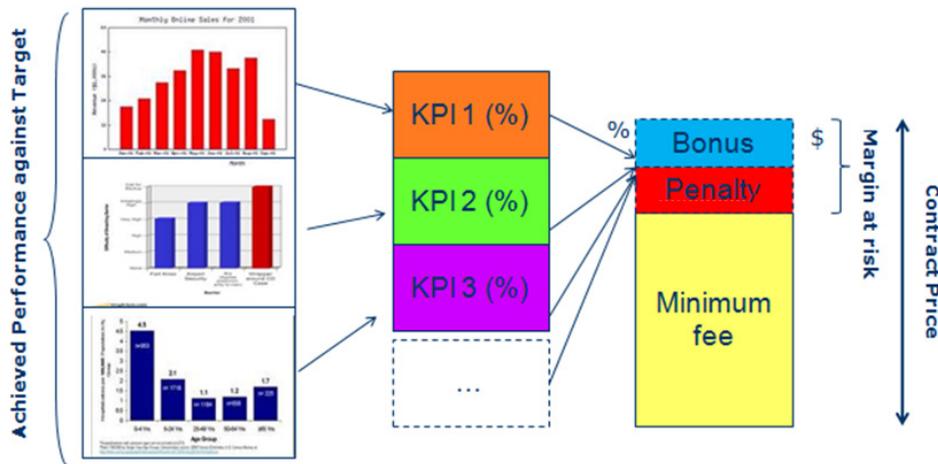


Figure 7: Bonus/Penalty per KPI (adapted from QinetiQ, 2011)

This principle is in practical terms limited to KPIs with a very clear relationship between value and monetary gains or losses. For some KPIs, this is clearly the case (e.g., budget performance), but for most other this is less clear.

**6.1.1.3 One or more KPI for calculation of bonus/penalty and the remaining KPIs used as measure against sub optimization**

In this alternative bonus/penalty is calculated solely on basis of the KPIs that have clear relationships between values and costs/gains. One example is to use the one KPI measuring the deviation from the vessel’s running cost budget. If there is a positive deviation (less money spent than budgeted) a bonus will be paid while a negative deviation (more money spent than budgeted) will result in a penalty.

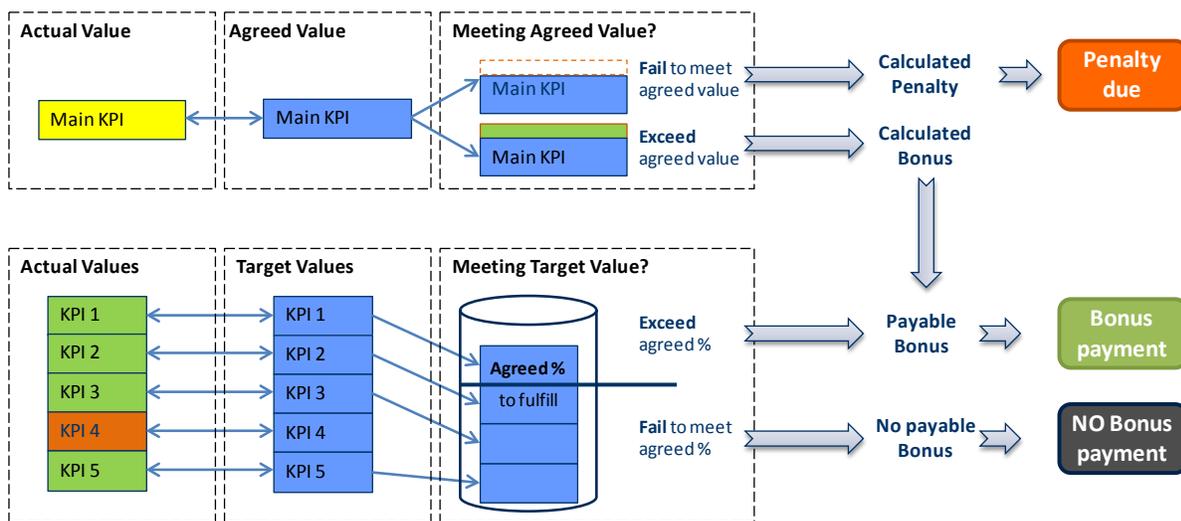


Figure 8: Bonus/Penalty per KPI with quality control

As full focus is given to the cost efficiency of the ship management operation there is a need to secure that the quality of the ship management operation does not go below an unacceptable level. This is secured through monitoring whether the other KPI Values are at a sufficient level (by comparing KPI Values with KPI Target Values).

#### *6.1.1.3.1 The main KPI: Budget Performance*

In this alternative main focus is given to a KPI which expresses the budget performance by comparing the actual running costs and accruals to the vessel's running cost budget (plus Additional Authorized Expenses, AAE). If the actual running costs and accruals are lower than budgeted, the ship manager is given a percentage of this "profit" while if the actual running costs and accruals are higher than the agreed running costs budget (plus AAE) the ship manager will be given a penalty corresponding to a certain percentage of the "loss". To give some margin to the manager, the target value for the KPI is therefore set to maximum 10% above agreed budget. Anything below 10% results in a bonus while anything above 10% results in a penalty. Again we refer to section 6.1.1.1 regarding definition of the amount at stake (the max potential bonus/penalty).

#### *6.1.1.3.2 The KPIs used as a measure against sub optimization*

As stated in the introduction to this section a sole focus on actual running costs and accruals may result in sub optimization meaning that the quality of service provided by the ship manager declines. To avoid this, a set of KPIs are selected to monitor the quality of service. For each KPI the ship manager and ship owner must agree on a target value defining the required level of quality. If a certain number of KPI target values are not met no bonus will be paid even though the KPI Value of the main KPI (budget performance) indicates that such a bonus should be paid. Another alternative is to calculate the average deviation from the KPI target values and decide that an eventual bonus should be paid if the average deviation from the KPI target values is either neutral or positive (meaning that on average the KPI target values are met).

#### *6.1.1.4 How this was done in the example*

For the example documented in this report, we decided to follow alternative 2: One KPI for calculation of bonus/penalty and the remaining KPIs used as measure against sub optimization<sup>12</sup>. The bonus/penalty is calculated by the percentile deviation from the budget. If the actual running costs are 5% higher than the target, 5% of the management fee will be withdrawn as a penalty. If the actual running costs are 5% lower than the target, 5% of the management fee will be paid as a bonus. The amount at stake was set to 25% of the management fee meaning that the max penalty is 25% of the management fee. This implies that the max bonus is also 25% of the management fee, securing that the ship owner and ship manager has the same stake at risk<sup>13</sup>. It was also

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<sup>12</sup> As opposed to Alternative 1 where each KPI would have been assigned a target value and a bonus/penalty related to the actual deviation from the KPI's target value.

<sup>13</sup> An alternative would be to restrict only the penalty side of this and keep the bonus side open. This will have to be agreed between the ship owner and the ship manager

decided that 90% of the KPIs selected as a measure against sub optimization would have to meet their respected KPI target values for any bonus to be paid. The potential penalty (if the budget is not met) will be inflicted regardless of whether the KPI target values are met.

How these decisions affect the further process of selecting KPIs and defining target values will be seen later in this report.

### 6.1.2 Selection of KPIs

There are two main issues related to the selection of KPIs to use in a performance based contract. Firstly the KPIs must fulfill the KPI selection criteria for use in Performance Based Contract in ship management and secondly the KPIs must fulfill the generic validation criteria for KPIs.

While the KPI selection criteria for use in Performance Based Contracts in ship management would primarily be used to select a relevant set of KPIs, the generic validation criteria for KPIs would be used mainly to create proper definitions (including measurements) for the KPIs. The figure below depicts this logic before we move on to the actual criteria.

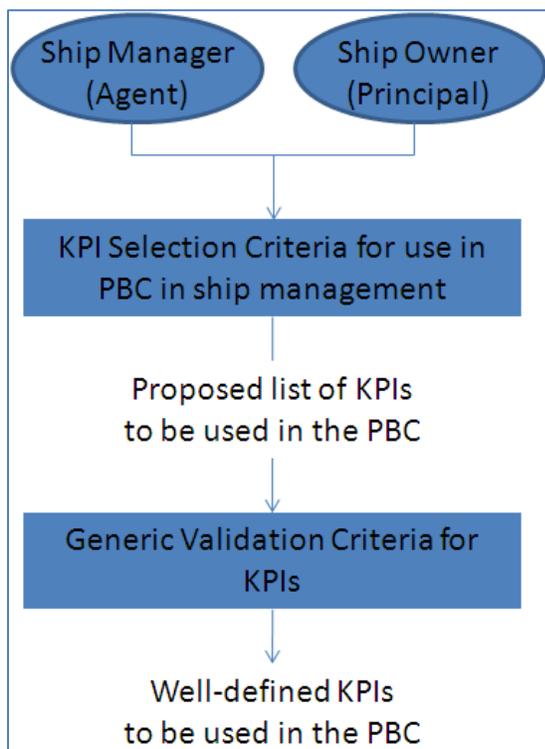


Figure 9: Selection and validation criteria for KPIs

### 6.1.2.1 Generic KPI validation criteria

The table below depicts six validation criteria used in the project Shipping KPI:

Validation Criteria	Definition
Observable and Quantifiable	It must be possible to observe and measure the performance by applying a recognized data-collection and scale of measurement
Valid indicator of performance	Especially concerned with criterion-related validity. Is the KPI actually measuring what we want it to measure?
Sensitive to Change	Must allow for early warning by capturing changes in an industrial system that have significant effects on performance. Will the score on the KPI over time reveal changes in performance (if such changes have taken place of course)?
Compatible	The KPI must be compatible with other indicators to prevent the decision-makers receiving contradictory control signals
Transparent and easily understood	The KPI must be easily understood in that its meaning is apparent and compatible with the user's theoretical understanding and unconscious mental models.
Robust Against Manipulation	The question is whether the indicator allows the organization to 'look good' by, for example, changing reporting behavior rather than making the necessary basic changes that improves actual performance. Is the Shipping KPI robust against initiatives for manipulating the score?

**Table 14: 6 generic KPI validation criteria (Kjellén, 2000).**

The Shipping KPI indicators have all been validated against these criteria.

### 6.1.2.2 KPI selection criteria for use in a Performance Based Contract in ship management

As seen in section 5 the main KPI selection criteria for use in a Performance Based Contract in ship management are:

- The KPIs should be linked to existing contractual obligations
- There must be a potential for over and under performance for all KPIs<sup>14</sup>
- The KPIs must be linked to owner's area of interest
- The KPIs must be close to 100% controllable by the ship manager

These are additional criteria to the six general criteria listed in the previous section and needs to be used for further validation of KPIs to be used in an actual PbC case.

### 6.1.2.3 How this was done for the example

The main challenges were to identify KPIs fulfilling both the KPI selection criteria for use in a Performance Based Contract in ship management and the generic validation criteria for KPIs. Section 5 in this report shows how KPIs from the project Shipping KPI are applicable for Performance Based Contracts in ship management. These KPIs (hereby called Shipping KPIs)

<sup>14</sup> This is not necessarily valid if the bonus/penalty is decided on basis of whether the budget is met and remaining KPIs are monitored to avoid sub optimization. In this case only the main KPI would need potential for both over and under performance

are already validated against and adapted on basis of the generic KPI quality criteria (in the Shipping KPI project itself) and as the validation of the KPIs against KPI selection criteria for use in Performance Based Contracts in ship management was done in section 5 we simply present the end results from section 5 in the table below. Only Shipping KPIs marked in bold are part of the example. This screening of potential Shipping KPIs was done on basis of choices made regarding the bonus regime (hereby including the Shipping KPI “Fire and Explosions”) as well as a general assumption that fleet specific Shipping KPIs should not be included (defining a scenario where the Ship manager manages only a selected set of vessels for the ship owner).

Shipping KPIs	Relevant for SHIPMAN addendum	Relevant for Flagship generic processes	Relevant for Ship owners' areas of interest	Comment
<b>Ballast water management</b>	Section 4: Technical Management Section 20: Compliance with law and regulations	A4.4 Run ship	Public opinion, CSR and Environment	
<b>Cargo related incidents</b>	Section 4: Technical Management	A4.4 Run ship	Environment	
<b>Conditions of class</b>	Section 20: Compliance with law and regulations	A4.4 Run ship		
<b>Contained spills</b>	Section 4: Technical Management			Oil majors will have an interest in this KPI
<b>Crew disciplinary frequency</b>			Public opinion	
<b>Crew planning</b>	Section 5: Crew Management and Crew Insurances	A4.2 Provide Crew	Crew treatment/condition, CSR	
<b>Budget performance</b>	Section 6: Commercial Management	A4.4 Run ship	Operational expenses	
<b>Drydocking planning performance</b>		A4.5 Maintain or repair ship		
<b>Environmental deficiencies</b>	Section 4: Technical Management		Regulatory deficiencies	
<b>Failure of critical equipment and systems</b>	Section 4: Technical Management	A4.4 Run ship A4.5 Maintain or repair ship	Asset technical condition	
<b>Fire and Explosions</b>	Section 4: Technical Management	A4.4 Run ship	Yes	No potential for out performance of the target value
<b>Flawless Port State Control Performance</b>	Section 4: Technical Management Section 20: Compliance with law and regulations	A4.4 Run ship	Safety, Regulatory deficiencies	
<b>Health and Safety deficiencies</b>	Section 5: Crew Management and Crew Insurances		Safety, Regulatory deficiencies	
<b>HR deficiencies</b>	Section 5: Crew Management and Crew Insurances		Crew treatment/condition, Regulatory deficiencies	
<b>Lost Time Injury Frequency</b>	Section 5: Crew Management and Crew Insurances		Safety, CSR and Crew treatment/condition	
<b>Lost Time Sickness Frequency</b>	Section 5: Crew Management and Crew Insurances		CSR and Crew treatment/condition	
<b>Navigational deficiencies</b>	Section 4: Technical Management	A4.4 Run ship	Regulatory deficiencies	
<b>Navigational incidents</b>	Section 4: Technical Management	A4.4 Run ship	Public opinion, CSR	

<b>Officer experience rate</b>	Section 5: Crew Management and Crew Insurances	A4.2 Provide Crew and A4.4 Run ship	Crew treatment/condition	Fleet specific KPI
Officer retention rate	Section 5: Crew Management and Crew Insurances	A4.2 Provide Crew		Fleet specific KPI
<b>Operational deficiencies</b>	Section 4: Technical Management		Regulatory deficiencies	
Passenger injury ratio	Section 4: Technical Management	A4.4 Run ship		As the vessels in the demonstrator do not carry passengers, this KPI is not relevant.
<b>Port State Control deficiency ratio</b>	Section 20: Compliance with law and regulations	A4.4 Run ship	Regulatory deficiencies	
<b>Port State Control detention</b>	Section 20: Compliance with law and regulations	A4.4 Run ship	Regulatory deficiencies	
<b>Releases of substances as defined by MARPOL Annex 1-6</b>	Section 4: Technical Management Section 20: Compliance with law and regulations	A4.4 Run ship	Public opinion, CSR and Environment	
<b>Security deficiencies</b>	Section 4: Technical Management		Regulatory deficiencies	
Training days per officer	Section 5: Crew Management and Crew Insurances	A4.2 Provide Crew		Fleet specific KPI, not ship.
<b>Vessel availability</b>	Section 4: Technical Management	A4.4 Run ship A4.5 Maintain or repair ship	Asset availability	
Vetting deficiencies	Section 4: Technical Management	A4.4 Run ship	Regulatory deficiencies(?)	Only relevant for vessels eligible for vetting inspections
CO2 efficiency			Public opinion, CSR and Environment	KPI not under the sole control by the ship manager
NOx efficiency			Public opinion, CSR and Environment	KPI not under the sole control by the ship manager
SOx efficiency			Public opinion, CSR and Environment	KPI not under the sole control by the ship manager

**Table 15 Shipping KPIs relevant for the Flagship demonstration**

### **6.1.3 Definition of KPI Target Values and bonus/penalty**

Once the decision has been made regarding which bonus/penalty regime to apply (section 6.1.1) and which KPIs to use (section 6.1.2) the KPI Target Values can be defined and bonus/penalty can be assigned. A clear and common understanding of the KPI definitions and how the ship manager's activities are affecting the KPI Values is of vital importance.

A potential baseline for these discussions is the industry averages for the KPI Values (if these are available) while another potential baseline is statistical analysis of historical data for the specific vessel. It may also be possible to do this independent of statistics, but as will be shown later, this can easily create problems. In the end however the target values are to be defined by the ship owner and ship manager in collaboration to drive delivery of the minimum level of service standard required by the ship owner to achieve his/her desired outcome/result/level.

As regard to baselines for determining KPI target values it is clear that different ships characteristics will lead to different potential to achieve specific target values. Age, use, maintenance, previous record in relation to a range of KPIs relating to the ship's condition, e.g. 'Number of conditions of class' and 'The number of vetting deficiencies'. It is then a clear disadvantage for the manager to be entering into a performance based contract where performance is mainly related to what a ship manager does not know, but the ship manager knows very well. There is a risk factor that can lead managers to avoid such a situation unless there is an "insurance premium" in form of a higher payment.

There are several things that would / could pose a counterweight to this drawback. Firstly, one can imagine that the KPIs relating to the ship may be weighted less. The ship manager can also be given a right to information regarding the ship from the former manager, class, etc. before the contract is signed so that the manager can assess the situation. Inspection of the ship in advance is another possibility. In addition, the manager could be given a right to renegotiate the KPI target values after a (grace or trial period). The concept of due-diligence type approach to Performance Based Contracting is likely as the consequence of a PBC may be large.

Once the KPI target values have been assigned the ship manager and the ship owner have to decide how the bonus/penalty should be calculated on basis of whether the target value is met. This decision is dependent on which bonus/penalty regime that was chosen. In the case of each KPI being assigned a percentage of the total amount at stake (see section 6.1.1.1) a decision must be made regarding when the maximum penalty should be inflicted (in cases where the KPI target value is not met) and when the maximum bonus should be paid (in cases where the KPI target value is out performed by the ship manager). In the case where one KPI is used for calculation of bonus/penalty and the remaining KPIs are used as measures against sub optimization the decision regarding bonus/penalty will be decided on basis of the lead KPI only. In addition the percentage of KPIs which will have to meet the target values for the bonus to be paid will have to be decided (see section 6.1.1.3).

### 6.1.3.1 How this was done for the demonstrator

For the main KPI (Budget Performance) the target value is defined as 10 (meaning maximum 10% above budget). For the remaining KPIs we used values that were first selected from a “common sense” idea of where one wants to be and secondly by adjusting to getting a suitable number of ships to pass the test.

Below we present the resulting target values per KPI. Please note that the selection process used was based on the limited selection of vessels that are reporting to the Shipping KPI system (about 400 vessels).

Relevant KPIs	Target values
Budget Performance	10
Ballast water management	0
Cargo related incidents	1
Conditions of class	2
Contained spills	0
Crew disciplinary frequency	1
Crew planning	3
Drydocking planning performance	10
Environmental deficiencies	1
Failure of critical equipment and systems	1
Fire and Explosions	0
Flawless Port State Control Performance	0 <sup>1</sup>
Health and Safety deficiencies	1
HR deficiencies	1
Lost Time Injury Frequency	5
Lost Time Sickness Frequency	250
Navigational deficiencies	1
Navigational incidents	0
Officer experience rate	0 <sup>1</sup>
Operational deficiencies	1
Port State Control deficiency ratio	1
Port State Control detention	0
Releases of substances as defined by MARPOL Annex 1-6	0
Security deficiencies	0,2
Vessel availability	0 <sup>1</sup>

**Table 16 KPIs and target values for the demonstrator (See notes below)**

*Note 1: These KPIs were omitted from the set as the data variability was too high to give sensible results for the demonstration. This is due to reporting problems and shows one of the benefits of using statistical data to determine KPIs and target values: One can also do selection of indicator sets based on expected quality of reported or reference data.*

Thus, a total of 21 KPIs were used for quality checks while the budget performance KPI was used for calculating bonus or penalty. Three KPIs were omitted due to lack of sufficient quality.

## **6.2 Auditing in a PbC setting**

If a Performance Based Contract is supposed to work, the parties must have access to information about the job being done. This requires active monitoring by the client, in this case the ship owner. The ship owner must therefore be given significant rights to the material used to calculate the values of the KPIs. SHIPMAN 2009 Part II Clause 13 (Budgets and Management of Funds) already gives a general right of access, but this should be clarified further in terms of the KPI Values.

It may be advantageous to schedule regular meetings to review the data with the ship manager. This will ensure awareness of the basic data and accurate input in daily life. When the ship is chartered out, there may be reasons to include the charterer in this type of review to ensure its rights (ref. what is said above regarding the financial interests between the manager and owner).

The evaluation during the auditing can be done, e.g., through half-yearly meetings and reporting in their financial statement format and explanation notes in accounting for certain aspects of operations. It may be necessary to adopt a “micromanagement” approach for efficiency and effectiveness of ship operations done at minimum waste cost. Further to the SHIPMAN 2009 clause 13(d) it is suggestive that the managers shall make such accounts available for inspection and auditing by the Owners and/or their representatives in the Managers’ offices or by electronic means, provided reasonable notice is given by the Owners.

Although a right to audit clearly has a major deterrent effect, there will be a challenge to find a mechanism that combines the ship owner’s right to audit the figures with a fair way to adjust the figures if the owner has well-founded objections

In best practice for methods of physical inspection it is important to select the most appropriate surveillance method for the effort involved. There are many acceptable methods of inspection ranging from a simple physical ‘kick the tires’ validation to a more structured surveillance designed to validate satisfactory completion of critical tasks. Acceptable surveillance methods, which are applicable to physical inspection of work being performed or validation of progress/status or self-assessment reports might be:

- 100 % inspection: This is usually the most appropriate method for infrequent tasks or tasks with stringent performance requirements, e.g., where safety or health is a concern. With this method, performance is inspected/evaluated at each occurrence. One hundred percent inspection is too expensive to be used in most cases
- Random sampling: This is usually the most appropriate method for recurring tasks. With random sampling, services are sampled to determine if the level of performance is acceptable. Random sampling works best when the number of instances of the services

being performed is very large and a statistically valid sample can be obtained. Computer programs may be available to assist in establishing sampling procedures.

- **Periodic Inspection:** This method, sometimes called ‘planned sampling’ consists of the evaluation of tasks selected on other than a 100% or random basis. It may be appropriate for tasks that occur infrequently, and where 100 % inspection is neither required nor practicable. A predetermined plan for inspecting part of the work, at predetermined critical inspections points, is established using subjective judgment and analysis of the facility’s resources to decide what work to inspect and how frequently to inspect it.
- **Customer Input:** Although usually not a primary method, this is a valuable supplement to more systematic methods. For example, in a case where random sampling indicates unsatisfactory service, customer complaints can be used as substantiating evidence. In certain situations where customers can be relied upon to complain consistently when the quality of performance is poor, e.g., dining facilities, building services, customer surveys and customer complaints may be a primary surveillance method, and customer satisfaction an appropriate performance standard. In all cases, complaints should be documented, preferably on a standard form.
- **Contractor Self-Reporting:** For things like system maintenance, the contractor can provide system records that document performance. Monthly reports that can detail problems encountered and what was done to resolve them.

#### **6.2.1 How this was done for the demonstrator**

The demonstrator does not include this step, but as Shipping KPIs have been used in the demonstrator the data would be available for auditing through the PI Values (the actual reported measurements used in calculation of the KPI Values).

### **6.3 Valuation of results**

The valuation of results could be an automatic quantitative procedure where the KPI Values are reported and compared to the KPI target values. On basis of this comparison the bonus/penalty is calculated.

In some cases there may be room or need for negotiations or discussions. Force Majeure could be a trigger for such qualitative valuation of results. If the ship manager is able to give an adequate reason for a KPI Value being below the target value the ship owner may agree to disregard this specific KPI. The right to negotiate the results should be agreed upon in due time before the validation of results is commenced. This needs to be included in the modified SHIPMAN contract.

### 6.3.1 How this was done for the demonstrator

Based on the PbC contract principles developed in previous sections, it is clear that there are four main cases to consider (when “better” also includes the measures being on target). The cases are summarized in the columns of the table below. The table also contains the percentages of the ships from the Shipping KPI database achieving these goals, based on three different quality criteria.

<b>Budget (10%)</b>	Better	Better	Worse	Worse
<b>Quality (See below rows)</b>	Better	Worse	Better	Worse
<b>Result for manager</b>	<b>Bonus</b>	<b>Even</b>	<b>Penalty</b>	<b>Penalty</b>
<b>Quality percentile 90% KPI – 19/21</b>	64 %	3 %	28 %	5 %
<b>Quality percentile 95% KPI – 20/21</b>	58 %	9 %	22 %	11 %
<b>Quality percentile 100% KPI – 21/21</b>	40 %	27 %	12 %	21 %

Table 17: Main cases for PbC demonstration and results from SKPI database

As the penalty is only dependent on the budget KPI, it will always kick in on one third of the cases (33%). The bonus will kick in on between 40 and 64% of the cases, dependent on the percentage of quality KPIs that needs to be satisfied. Although this is based on a limited selection of ships, it seems to make sense for both owner and manager.

Although the outcome for the parties seems to be asymmetric as there are two cases that give a penalty while only one give a bonus, this does not matter much. Firstly, the no penalty/no bonus fee should be agreed upon at a baseline of satisfying the quality related KPIs at an acceptable level. Thus, the owner will not want to pay any excess to get a higher quality level. Also, the fee as well as budget has to be set so that both parties agree on the terms and can accept any bonus or penalty based on that. The availability of the Shipping KPI database to calibrate these limits is an important prerequisite for establishing this type of regime.

Before we describe the valuation for each vessel we recap the defined bonus/penalty regime for the demonstrator (see section 6.1.1.4):

The main KPI is the KPI Budget Performance (expressing to which degree the running costs budget was met). Its target value is 10% (meaning that the budget is met within a margin of 10%). If the ship manager spends less than the budget the bonus will be the same percentage of the management fee while if the ship manager spends more than 10% over the budget the penalty will be the corresponding total percentage of the management fee. In both cases, the bonus or penalty is limited to 25%. The bonus will only be paid if the quality KPI target is simultaneously met. The penalty is independent of the quality indicators. For this demonstration the requirement for payment of bonus is 90% satisfaction of KPIs, i.e., maximum 2 of 21 KPIs not satisfied.

Note that the actual running costs and how this amount is reimbursed by the ship owner to the ship manager are taken out of the equation. The validation shown below assumes that the ship

owner reimburses the actual running costs to the ship manager regardless of whether these are above, equal to or below budget.

How the demonstration ships meet KPI requirements:	Relevant KPIs	Ship 1	Ship 2	Ship 3	Ship 4
	Ballast water management	YES	YES	YES	YES
	Cargo related incidents	YES	YES	YES	YES
	Conditions of class	YES	YES	YES	YES
	Contained spills	YES	YES	YES	YES
	Crew disciplinary frequency	YES	YES	YES	YES
	Crew planning	YES	YES	YES	YES
	Drydocking planning performance	YES	YES	YES	YES
	Environmental deficiencies	YES	YES	YES	YES
	Failure of critical equipment and systems	YES	YES	YES	YES
	Fire and Explosions	YES	YES	YES	YES
	Health and Safety deficiencies	NO	NO	YES	NO
	HR deficiencies	YES	YES	YES	YES
	Lost Time Injury Frequency	YES	YES	YES	YES
	Lost Time Sickness Frequency	YES	YES	YES	YES
	Navigational deficiencies	YES	NO	YES	YES
	Navigational incidents	YES	YES	YES	YES
	Operational deficiencies	YES	YES	YES	YES
	Port State Control deficiency ratio	YES	NO	YES	NO
	Port State Control detention	YES	NO	YES	YES
Releases of substances (MARPOL Annex 1-6)	YES	YES	YES	YES	
Security deficiencies	YES	NO	YES	NO	
For the Ship Owner:	Running costs budget (RCB)	1,365.830	1,365.830	1,365.830	1,365.830
	Budget performance	1,02	0,98	0,93	1,16
	Actual running costs (ARC)	1,393.147	1,338.513	1,270.222	1,584,363
	Difference below zero/over 10% (<0 is below)	0	27.317	95.608	-218.533
	Percentage at stake	0,0 %	2,0 %	7,0 %	-16,0 %
For the Ship Manager:	Management fee:	143.445	143.445	143.445	143.445
	Calculated bonus/penalty:	0	2.869	10.041	-22.951
	Percentage of KPIs meeting Target Value:	95	76	100	86
	Actual bonus/penalty	0	0	10.041	-22.951
	Total amount payable to ship manager:	143.445	143.445	153.486	120.494

Table 18: Demonstration cases

The table has used default costs as discussed earlier and selected four different ships from the database that exemplifies some issues related to the performance based contract:

1. Ship one has a slight overrun on costs, but below the 10% margin. No penalty is given regardless of quality KPIs.
2. Ship two is lower on costs than budget, but at a lower quality indicator and no bonus is paid. However, there will not be a penalty.
3. Ship three has a better budgetary performance while quality indicators are high. A bonus is paid.
4. Ship four has a significant overrun on costs and a penalty is subtracted from fee, independent of quality indicators.

A number of variations on this theme can be made, but the concept should be clear now. Monetary gains or losses are shared between manager and owner, but bonus is only paid if quality standards are maintained.

Many other schemes can also be devised. A main point, however, is that it is difficult to argue for or against any given scheme if one has not access to statistical data to show how this would work in the current regimes. This is one of the significant contributions that the Shipping KPI database can give to the community.

## 7 From manager/owner to integrated operations in shipping

### 7.1 Ship management has an important impact on the operation

As discussed earlier, the management cost of the shipping operation is not very high, relative to other costs. A typical management cost may be in the range of USD 300 to 400 as discussed earlier. This cost will be included in the charter hire. If we look at an estimated view of the costs seen from the charterer, this can be summarized as below. This does not include “unexpected” elements such as off-hire, demurrage or similar costs. The figures in the table is again based on a Handymax bulk carrier (25 000 to 40 000 Dwt). Obviously, all prices vary very much, dependent on the market situation and other factors. The figures shown here are only examples.

Cost item	USD/Day
Charter hire	8.000
Fuel (30 ton/500 USD)	15.000
Port costs	7.000
<b>Total</b>	<b>30.000</b>

**Table 19: Total cost breakdown example as seen from charterer**

The charter hire will typically be calculated to cover the owner’s operational and capital costs as well as include reasonable revenue. Thus, a management cost of USD 300 per day represents only 1% of the total costs as represented by the agreement between owner and charterer. On the other hand, good management and quality crew can have a great impact, e.g., on unplanned off-hire. Each day unplanned off-hire represents 27 days of management costs at the above rates. Thus, using an incentive enhancing contract between owner and manager can clearly give significant benefits for the former.

For the charterer, the quality of management will probably be even more important. A two percentage reduction in fuel consumption represents the full management cost in the above example! However, this cannot easily be captured in performance based contracts between owner and manager unless the owner is able to recover this as a higher charter rate.

### 7.2 The example can be generalized

As the charterer normally pays for fuel it is also clear that the concept of performance based contracts could be extended to the charterer – owner relationship. Improved operation (with the help of management) could reduce fuel consumption which gives potentially very high savings for the charterer.

Likewise, similar forms of contracts could be set up between ports and terminals/stevedores and owner/charterer to reduce demurrage, fuel consumption or ancillary costs associated with port stays.

### 7.3 All parties need to pull together

The IMO GHG study (IMO 2009) lists a range of possible measures to reduce GHG emissions and the associated costs. Interestingly enough, many of these measures have negative cost, meaning that they will save the shipping industry money if implemented. However, a significant problem is the “split incentive” that exists between the parties in the business: Those that pay for the improvement may not be the ones that get the profit.

The data from the IMO study is listed below. All estimates are given as a low, centre and high estimate. The first set of data is marginal cost associated by saving one ton of emission and the second group is the yearly potential saving in million metric tons. The shadowed rows represent operational improvements that do not need particular technical retrofit or changes. As one can see, there are a very high savings potential in operational and maintenance measures that do not require any technical modifications.

	Cost efficiency (US\$/tonne of CO2)			Maximum abatement potential (Mt)		
	Low	Centre	High	Low	Centre	High
<b>Retrofit hull measures</b>	-140	-155	-160	10	30	55
<b>Voyage and operational options</b>	-140	-150	-160	5	25	45
<b>Air lubrication</b>	-90	-130	-150	10	20	25
<b>Propeller-propulsion upgrades</b>	-70	-115	-155	45	50	60
<b>Other retrofit options</b>	-75	-110	-135	40	70	100
<b>Hull coating and maintenance</b>	-65	-105	-140	15	40	65
<b>Propeller maintenance</b>	-65	-75	-120	25	45	65
<b>Auxiliary systems</b>	250	80	-90	2	5	10
<b>Speed reduction</b>	80	110	135	90	100	110
<b>Main engine improvements</b>	470	175	-120	1	5	10

**Table 19: Marginal abatement costs from IMO GHG Study**

Also, the purely voyage and operational options (row 2) can give a very high return on investments. At the center estimates these measures can represent a 3 750 million USD savings worldwide. The operational measures include propulsion performance optimization, fuel use optimization, weather routing and improved autopilots.

As the benefit from these measures partly depend on improved cooperation by the parties within the shipping operation and partly on resolving the split incentive problem, performance based contracts can play a major role in realizing these economical gains and corresponding savings in emissions.

## 8 Conclusions

This paper has gone through the principles of performance based contracting between ship owner and manager and developed a demonstration of these principles based on the Shipping KPI database. It has been shown how it could work and what the results would be in a close to real world setting. It has also been shown how parameters can be tuned, based on statistics from the Shipping KPI database, so that a fair distribution of risk between the partners can be agreed on.

One argument in this paper is that performance based contracting, when done properly, will give a better share of risks and profit possibilities and by that improve the cooperation between the owner and the manager. We believe that the examples provided show that this is the case.

The development of the Shipping KPI database makes it possible to test different PbC schemes against recorded data. Further more, the Shipping KPI indicators defines a standard set of KPIs that can be used in standardized PbC schemes, e.g., based on the SHIPMAN contract format. The Shipping KPI framework can also provide a mechanism for collecting and validating the KPI values used in PbC.

On the other hand, there are problems with PbC that one needs to be aware of. The report has also discussed these and pointed to some solutions. We believe that none of the problems are insurmountable and that benefits outweigh the problems.

Finally, in light of the findings in IMOs second green house gas study (IMO 2009), it is clear that operational efficiency in shipping needs to be much improved. This will depend both on overcoming the split incentive problem (those that pay are not those that gain) and better coordination of parties to realize both economical and GHG emission gains in future ship operations. Performance based contracting will be an important component of more integrated shipping operations.

Future research should in particular investigate how parameters that the manager and owner have only partial control over (e.g., fuel use and port activity timings) can be incorporated in a PbC scheme. It is also important to improve the data quality and size of the Shipping KPI database so that better statistical quality can be used with greater accuracy in detailing the PbC schemes discussed in this report. Finally, one should also investigate how data not currently covered in Shipping KPI can be collected. This does apply, e.g., to chartering and port/terminal operations.

## 9 References

- Al-Subhi Al-Harbi, K.M (1998). Sharing fractions in cost-plus-incentive-fee contracts, *International Journal of Project Management*, 16 (2): 73-80
- D'Antonio, S., D'Arienzo, M., Esposito, M., Romano, S.P., Ventre, G. (2004). Managing service level agreements in Premium IP networks: a business-oriented approach, *Computer Networks*, 46 (2004): 853-866
- Arshinder, K.A. and Deshmukh, S.G. (2009). A framework for evaluation of coordination by contracts: A case of two-level supply chains, *Computers & Industrial Engineering*, 56 (2009): 1177–1191
- Bes, J (1951) . Chartering and shipping terms (1951): 1-51
- Damnjanovic, I. and Zhang, Z. (2008). Risk-Based Model for Valuation of Performance-Specified Pavement Maintenance Contracts, *Journal of Construction Engineering and Management*, July 2008
- Datta, P.P. and Roy, R. (2010). Cost modeling techniques for availability type service support contracts: A literature review and empirical study, *CIRP Journal of Manufacturing Science and Technology*, 3 (2010): 142–157
- Domberger, S. (1998). *The contracting Organization: A Strategic Guide to Outsourcing*. Oxford university Press.
- Englmaier, F. and Wambach, A. (2010). Optimal incentive contracts under inequity aversion, *Games and Economic Behavior* 69 (2010) 312–328
- Eruktu, C. and Richelle, Y. (2007). Optimal Licensing Contracts and the Value of a Patent, *Journal of Economics and Management Strategy*, 16 (2): 407-436
- Fearnley, N., Bekken, JT, Norheim, B. (2004). Optimal performance-base subsidies in Norwegian intercity rail transport, *International Journal of Transport Management*, 2 (2004): 29-38
- Golec, J. and Starks, L. (2004). Performance fee contract change and mutual fund risk, *Journal of Financial Economics*, 73 (2004): 93-118
- Gopal, A. and Koka, B.R. (2010). The Role of Contracts on Quality and Returns to Quality in Offshore Software Development Outsourcing, *Decision Sciences Journal*, 41 (3): 491-515
- Heinrich, C.J. and Choi, Y. (2007). Performance-Based Contracting in Social Welfare Programs. *The American Review of Public Administration*, 37(4), pp 409-435.

- Hooper, L. (2008). Paying for performance: Uncertainty, asymmetric information and the payment model, *Research in Transportation Economics*, 22 (2008): 157–163
- Hannah, G., Ray, M., Wandersman, A., Chien, V. (2010). Developing performance-based contracts between agencies and service providers: Results from a Getting To Outcomes support system with social service agencies, *Children and Youth Services Review*, 32 (2010) 1430–1436
- Hensher, D.A. and Houghton, E. (2004). Performance-based quality contracts for the bus sector: delivering social and commercial value for money, *Transportation Research, Part B* 38 (2004): 123–146
- Hensher, D.A. and Stanley, J. (2008). Transacting under a performance-based contract: The role of negotiation and competitive tendering, *Transportation Research Part A*, 42 (2008) 1143–1151
- Hensher, D.A and Stanley, J. (2003). Performance-based quality contracts in bus service provision, *Transportation Research, Part A*, 37 (2003): 519–538
- Homburg, C. and Stebel, P. (2009). Determinants of contract terms for professional services, *Management Accounting Research*, 20 (2009): 129–145
- Hypko, P., Tilebein, M. and Gleich, R. (2010). Clarifying the concept of performance-based contracting in manufacturing industries, *Journal of Service Management*, 21 (5): 625-655
- IMO (2009) Prevention of Air Pollution from Ships, Second IMO GHG Study, MEPC 59/INF.10, 9 April 2009.
- Kim, S.H., Cohen, M.A, and Netessine, S. (2007). Performance Contracting in After-Sales Service Supply Chains, *Management Science*, 53(12): 1843–1858.
- Lai, E.L-C, and Riezman, P.W. (2009). Outsourcing of innovation, *Econ Theory* (2009) 38: 485-515
- Lambertides, N. and Louca, C. (2008). Ownership structure and operating performance: evidence from the European maritime industry, *Maritime Policy & Management*. 35(4), pp 395 — 409.
- Large, R.O. (2011). Partner-specific adaptations, performance, satisfaction, and loyalty in third-party logistics relationships, *Logist. Res.*, DOI 10.1007/s12159-011-0047-8
- Ng, I. C.L., Maull, R., Yip, N. (2009). Outcome-based contracts as a driver for systems thinking and service-dominant logic in service science: Evidence from the defense industry, *European Management Journal*, (2009) 27: 377– 387
- Oltedal, H.A. and McArthur, D.P. (2011). Reporting practices in merchant shipping, *Safety Science*, 49(2): 331-338

Osei-Bryson, K.M. and Ngwenyama, O.K (2006). Managing risks in information systems outsourcing: An approach to analyzing outsourcing risks and structuring incentive contracts, *European Journal of Operational Research*, 174 (2006) 245–264

Qinetiq (2011). Performance Based Contracting: an overview, QinetiQ Novare. Retrieved from [http://www.qinetiq.com/home\\_au/consulting/performance\\_based\\_contracting/what\\_is\\_performance\\_based\\_contracting.SupportingPar.68042.File.PDF/QinetiQ\\_Novare\\_PBC\\_Summary1.pdf](http://www.qinetiq.com/home_au/consulting/performance_based_contracting/what_is_performance_based_contracting.SupportingPar.68042.File.PDF/QinetiQ_Novare_PBC_Summary1.pdf), last access mai 2011.

SHIPMAN (1998, 2009). Standard ship management contracts developed by Intertanko.

Shumsky, R.A. and Pinker, E.J. (2003). Gatekeepers and Referrals in Services, *Management Science*, 49 (7): 839-856

Tarakci, H., Tang, K., Moskowitz, H. and Plante, R. (2006). Maintenance outsourcing of a multi-process manufacturing system with multiple contractors, *IIE Transactions*, (2006) 38: 81–92

Tate, W.L., Ellram, L.M., Bals, L., Hartmann, E. and van der Valk, W. (2010). An Agency Theory perspective on the purchase of marketing services Industrial, *Marketing Management* 39 (2010) 806–819

Terman, J. and Yang, K. (2010). Contracting and The Performance Assessment Tool: Politicization or Sound Management?, *PAQ*, Fall 2010

Wijnolst Niko and Wergeland Tor. Shipping innovations (2009)

Williamson, O. E. (1985). *The Economic institutions of capitalism*, Free Press.

Zhao, R.R. (2008). All-or-Nothing Monitoring, *American Economic Review*, 98 (4): 1619-1628