MASTER

Utilizing e-procurement tools for reducing TCO at Heerema Marine Contractors

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Award date:
2008

Leiden, August 2008

Utilizing e-procurement tools for reducing TCO at Heerema Marine Contractors

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In partial fulfilment of the requirements for the degree of:

Master of Science in Innovation Management

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TUE. Department Technology Management.
Series Master Theses Innovation Management

ARW 2008 IMA

Subject headings: Procurement, MRO, e-procurement.

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Leiden, august 2008





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Abstract

This thesis reports on the outcomes of a design study which aim is to investigate what new purchasing methods can decrease Total Cost of Ownership (TCO) within Heerema Marine Contractors (HMC). The study has been conducted as part of a five month internship at HMC, in the Leiden office. Main finding from the TCO analysis was that in all sections within the procurement department except for the vessel purchasing group, TCO is for the largest part determined by the direct purchasing costs. For the vessel purchasing group counts that processing purchase requests makes up the majority of the costs in the TCO.

A number of different conceptual solutions were worked out for the vessel purchasing group which can potentially reduce TCO at HMC; frame agreements, Electronic Data Interchange, e-reversed auctions, supply base reduction, and vendor management. After conducting a costs-benefit trade-off, e-reversed auctioning was found to be the solution which was estimated to result in the largest Return On Investments (ROI of 7.4). The solution e-reversed auctioning was further elaborated on in a solution design, and a change plan has been written to implement this solution.

Management Summary

Introduction

More, and more companies experience, and become aware of the added value purchasing can offer. This is also the case at Heerema Marine Contractors (HMC), where due to all kinds of factors, purchasing has become a department with increased impacts on HMC's financial, and operational performance.

The starting point for this Business Problem Solving Project (BPSP) originates from the perceived high direct acquisitioning costs, and costs associated with the processing of Purchase Requests (PR) within HMC's purchasing organization. The goal of this study is to find innovative means to decrease these costs.

Business design plan

This study's focal question originates from HMC's presumption that *more innovative ways of purchasing can save on direct purchasing as well as process costs,* and reads as follows: *"What new purchasing methods can decrease Total Cost of Ownership (TCO) within Heerema Marine Contractors"*. The questions which are answered during this study in a sequential order are:

- What are the most important cost drivers, processes, and methods used to acquire materials, equipment, manpower, and on a departmental level? What section should be focused on?
- What evidence can be gathered to cross validate finding, and what disconfirms findings from the departmental analysis for a specific purchasing group?
- What solutions could be promising for HMC considering its current situation? Furthermore, what is the most promising solution taking into account the ROI of each solution?
- How should the most promising solution look like in detail?
- What is the best manner to implement this solution in HMC's current situation?

Data for analysing the current situation is gathered via observations, interviews, questionnaires, and consultation of archival records. Causes and effects were cross validated as much as possible by methodological triangulation. Common sense and logical reasoning (deduction, induction, and abduction) were used to combine findings, come up with directions for change, and design a change plan to cope with the business problem(s) at hand.

Theoretical foundation

The theoretical basis for this business solving project lies in the field of business to business procurement with special emphasis on MRO (Maintenance, Repair, and Overhaul items) purchasing combined with theory, and practices of TCO models and purchasing portfolio models. Potential directions for change are also treated on a theoretical level in this section: Supply base reduction and supplier management, frame agreements, electronic data interchange, catalogue systems, and Internet Reversed Auctions (eRAs).

Empirical analysis and diagnosis
The departmental empirical analysis shows that each section and procurement group has its own specific procurement methods and dominant cost drivers when it comes to TCO for the items each group procures. For all the procurement groups, except the vessel purchasing group counts that direct acquisition costs account for the largest portion of costs. For the items purchased by the vessel purchasing group, the administrative costs account for the majority of TCO (see Table 1).

Table 1: Overview of dominant cost drivers per section

From the departmental analysis can be concluded that optimizing the vessel purchasing group's processes is the most rewarding for this study due to the high costs associated with the process (due to the large number of line items, PO's, vendors, etc.) and possibilities to decrease these costs (automation, change processes, etc.). Furthermore this group's workload will increase in the near future when the new built vessel becomes operational. As a result of the findings from the departmental analysis, consultation of my company and university supervisors in combination with personal interests the decision has been made to focus on the vessel purchasing group in the consecutive focused study.

During the focus study within the vessel purchasing group the following findings are found to be most important:

- The costs associated with processing a PR are found to be $ 259,- on average. This is quite high, especially considering the average value of the items purchased.
- It was found that the number of suppliers is one of the main drivers for increasing process costs since; the number of suppliers has a direct impact on procurement activities (i.e., finding, negotiating, and making contracts with suppliers, vendor management, resolving issues around deliveries and invoices of vendors, etc.).
- A low number of vendors is responsible for the majority of spend. From those vendors which are used infrequent and receive little orders account for the majority of PO's which need additional time to process.

- Currently there is no diversification in sourcing strategy. The current sourcing strategy could be categorized as a strategy which is most applicable for bottleneck items. Since there is also a large amount of spend in the leverage, and non-critical quadrants, a diversified sourcing strategy for these items could be beneficial.

The following solutions are found to be most suited according to literature, and empirical findings within HMC: frame agreements, Electronic Data Interchange, E-ordering, e-reversed auctioning, and supply base reduction in combination with vendor management. These solutions are presented, and evaluated on a conceptual level. During the conceptual design phase it was concluded that Electronic Data Interchange, and E-ordering could not be implemented due to the current working methods, and procedures, which had to be changed in such a radical manner that these solutions would not comply with HMC's requirements for a potential solution. From all other conceptual designs, e-reversed auctioning was found to have the largest potential when it comes to the expected Return On Investments (ROI) per solution concept (See Table 2).

	Annual software fee	Expected required personel (in FTE per year)	Year expenses per FTE	Labour costs (annually)	Costs total (per year)	Potential gains (yearly)	ROI
Supply base reduction	$ -	0.5	$ 101,237	$ 50,619	$ 50,619	$ 80,000	1.6
Frame agreements	$ -	0.33	$ 101,237	$ 33,746	$ 33,746	$ 65,000	1.9
E-auctioning	$ 10,500	1.5	$ 101,237	$ 151,856	$ 162,356	$ 1,200,000	7.4

[1] Costs for software license € 3000,- + € 500 per auction times 15 (Vendor: Quell)

Table 2: Cost-benefit analysis of the different conceptual solutions

Since e-reversed auctioning was found to result in the largest gains when it comes to ROI per conceptual solution, this solution concept was further delineated in a solution design. The solution design comprises a stepwise process for executing an eRA, including a decision model for HMC to decide whether to use eRAs as a procurement tool (See Figure 1) together with a formula for calculating whether e-auctioning would be favourable over an RFx process, or trade negotiations.

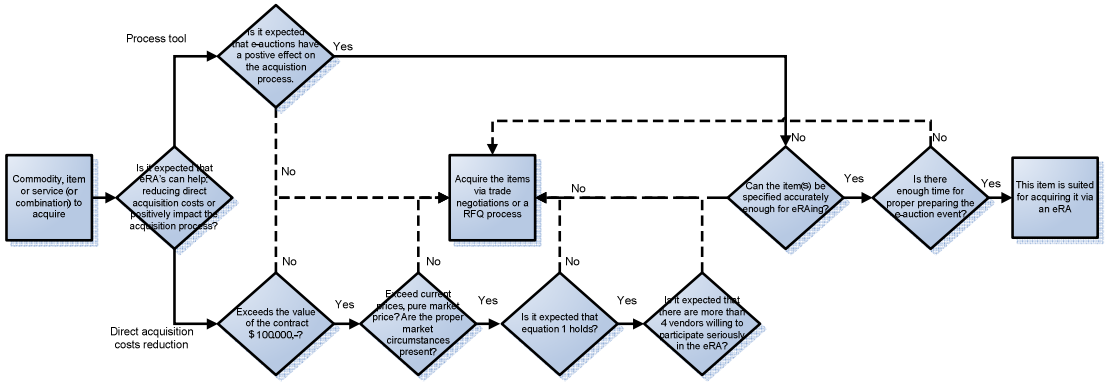

Figure 1: Decision model whether to use eRAs, or not

$$E + Ce < Crfx + RFx$$
$$E = e - auction\ event\ costs$$
$$Ce = Expected\ TCO\ of\ the\ goods\ when\ acquired\ via\ an\ e - auction$$
$$Crfx = Expected\ TCO\ of\ the\ goods\ when\ acquired\ via\ an\ RFx\ process\ or\ trade\ negotiations$$
$$RFx = Costs\ of\ the\ RFx\ process\ or\ trade\ negotiations$$

Equation 1: Costs benefit trade off between an ERA, RFx, or trade negotiations

In order to help HMC in choosing the most appropriate eRA design, the design variables, their appropriateness in different contexts and impact on the eRA results are delineated. Furthermore a decision model for choosing the most appropriate eRA design (See Figure 2) has been proposed for HMC.

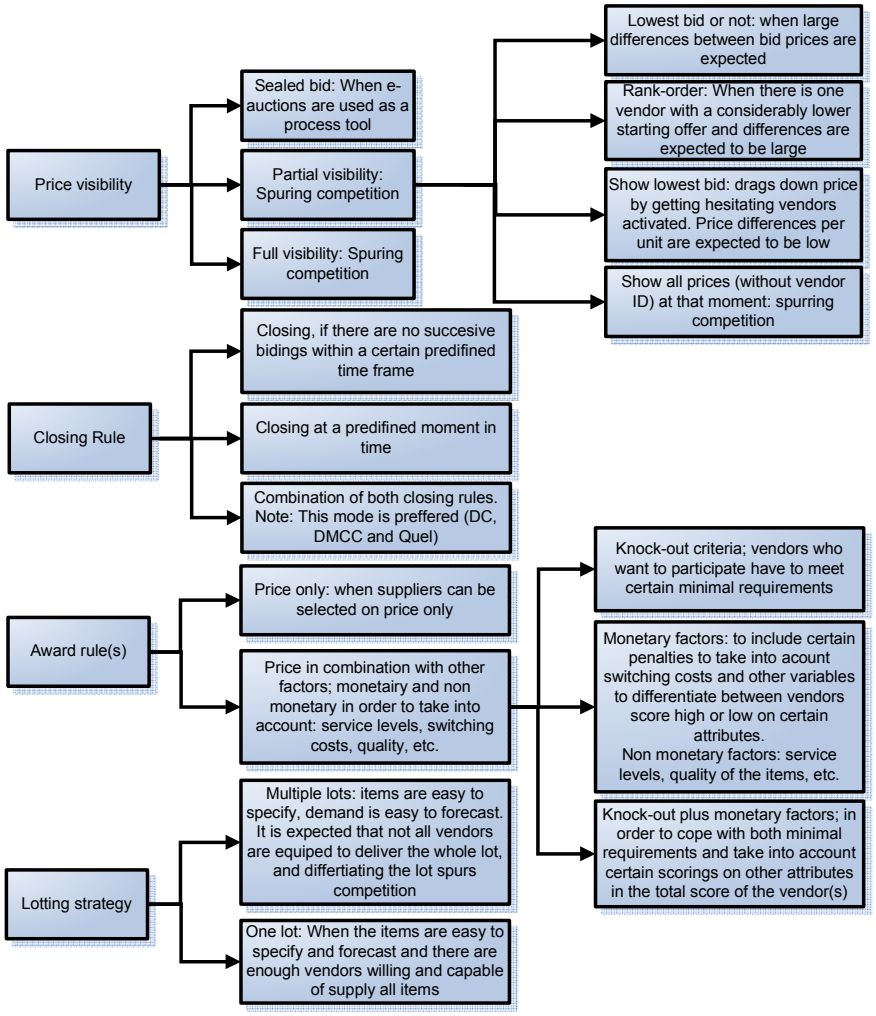

Figure 2: eRA design decisions, and considerations

To implement, and embed the suggested solution in the company a change plan has been written. The change plan comprises an eight step change approach based on the implementation approach as suggested by Kotter (1996), which has been customized to fit HMC's current state of affairs. In accordance with the implementation strategy an action plan has been advised to create short term wins, and educate HMC on the use of eRAs.

In the change plan special emphasis has been given to the topic of managing the buyer supplier relationship of HMC, because it has been found that this is of special importance when utilizing eRAs. The following recommendations for managing the buyer-supplier relationship are made:

- Monitoring what impact the auctions have on the buyer supplier relationships (HMC's reputation as a trade partner,). When eRAs are held, HMC should ask for feedback on the eRA process, rules, communication, etc. This information most likely improves the way trade partners perceive the reliability of HMC.
- Communicate the potential benefits for a supplier: Process improvements (reduced cycle time), a chance to retain current business, or as a possible mean to expand their current business when a supplier becomes a vendor of HMC as a result of an eRA, an opportunity to gain valuable insights into their competitive standing within their particular market environment. This will increase vendor's willingness to participate in eRAs ex ante. It should be noted that vendor's expectations should not be raised to high in order to prevent a situation wherein the event's outcomes don't meet those expectations.
- Providing timely, sufficient and constructive feedback on all participating suppliers (winners and losers). HMC should try to offer this feedback within a week time, to make sure that the event is still fresh in the memory of the vendor's and they are able to think back of how things worked out during, upfront, and after the event.
- Guaranteeing suppliers that no deceptive practices will be tolerated (phantom bidders, bidding of unqualified bidders). HMC should guarantee that the eRA event will be executed as ethically as possible and at least as ethical as it would be in a RFx process, or via trade negotiations. Communicating eRA rules and supplying feedback about the eRA event afterwards will help to direct the supplier's perception on these aspects in a positive direction.
- Be as transparent as possible when it comes to how the eRA event will be executed. All vendors participating have to have a good understanding of how the awarding process, rules and procedures are, upfront of the event.
- To increase the perceived integrity of the online bidding event, an independent third party could be hired to conduct the eRA event. This decreases the vendor's fear that the buying party may use deceptive practices (phantom bidders, bidding of unqualified bidders) to manipulate the outcomes of the event in favor of the buying party.
- Provide help and assistance during the auction event, enable constant communication when necessary. This will make suppliers more comfortable participating and takes away the anonymity of the online environment.

Conclusions and reflection on the project

As a result of the business problem solving project at HMC the following crucial recommendations surfaced:

- Frame agreements: frame agreements can save a forecasted $ 65 K annually (See, Table 2). Furthermore, when first frame agreements are put into effect it enables automating the ordering process by means of electronic data interchange in a later stage.
- This author advises to start monitoring current vendors more actively and reduce the number of vendors when possible in an appropriate manner. This will most likely result in process as well as direct acquisition costs savings due to bundling, a decrease in process delays, improved quality and service levels. Expected annual gains are estimated to be $ 80 K (See, Table 2).
- eRAs: The expected gains which can be made within HMC by decreasing the direct acquisition costs by means of eRAs amounts up to $ 1.2 M annually (See Table 2: Cost-benefit analysis of the different conceptual solutions (See, Table 2).

Next, to a practical contribution for HMC as a result of this thesis, it provides a contribution to academic literature as well. This study's empirical evidence and analysis contributes to the purchasing body of knowledge by using a TCO approach for determining which areas and sections one should focus on given the section's procurement practices and their effect on TCO. It has been found that a TCO approach gains many insights in the most promising direction for improving business processes and new tools to use at HMC as an offshore marine contractor. Furthermore, evidence has been provided that eRA's can be a valuable procurement tool in the dredging and marine contracting industry as a result of interviews held at DMCC[1] and DC[2]. In addition indications have been provided that e-reversed auctioning could also be of help in reducing TCO at HMC. Results of both tools in these specific industry settings (dredging and marine contracting industry) haven't been reported on, until now.

[1] 'DMCC' is a fictive name for a global player in the Dredging and Offshore Marine Contracting industry.
[2] 'DC' is a fictive name for a global player in the Dredging industry.

Preface

This report is the final product of my graduation project for my Master in Innovation Management at the Technical University of Eindhoven. The project has been carried out at the procurement department of HMC in Leiden.

The central topic of this study was to decrease TCO at HMC by focusing on the impact of procurement on this matter. This endeavour has been a very interesting, and inspiring one for me. Not only did it provide me with a unique opportunity to fully dive into several theoretical aspects of procurement, I also learned a lot by experiencing procurement practices outside the theoretical doctrine of an academic environment. The whole experience increased my interest in purchasing management practices.

My sincere gratitude goes out to HMC, for providing me the opportunity of conducting my graduation project at their company. The great support and interest in my project from all my colleagues made performing this project an interesting and pleasant undertaking. At the same time, colleagues where always there to provide me with challenging questions, and new insights, which resulted in more profundity in the research outcomes. From all colleagues at HMC, I would like to especially thank Rob Witkam, Edwin de Korte, and Michel Hendriks, who have offered me valuable and professional guidance and support, during this project.

From all persons involved in my graduation project at Eindhoven University, I would like to especially thank my supervisors, Dr. Ir. Isabelle .M.M.J. Reymen and Dr. Ir. Wendy van der Valk. Their advice and steering during the project navigated me when I seemed to lose my way. Furthermore, the critical suggestions and valuable input I received from all members of 'Afstudeerkring Purchasing and Supply Management, 2008' during this project were very advantageous for me to come to the end result of this study.

Last but definitely not least, my gratitude goes out to my co-students, friends and family. Where a special thanks goes out to my parents Arnold and Bernadette van der Maarel and my two sisters: Tessa and Mira van der Maarel. Their confidence in my capabilities, and the support and motivation they gave me helped achieving my goals during my time as a student.

Joost van der Maarel
August, 2008

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Introduction

In most companies, procurement has always been seen as an operation which is not that important (e.g. Kauffmann, 1999). This view changed over the last decades (e.g. Kaufmann, 1999). Nowadays, procurement is increasingly seen as a strategic function in the value chain, and a driver in the extended supply chain. There are many reasons for this enhanced popularity. Particular sources of this popularity may be traced back to such areas as trends in global sourcing, emphasis on time to market, product quality-based competition, customer uncertainty, and the need to improve bottom-line results (Kalakota & Robinson, 2001). Hence, most companies spend more than half of their turnover on purchased parts and services, and decreasing Total Costs of Ownership (TCO), for this and all other abbreviations see Appendix I: List of abbreviations) of procured materials and services directly impacts bottom line results (e.g. Van Weele, 2005). This is the reason that more and more companies experience and become aware of the added value, purchasing can offer them. This is also the case at Heerema Marine Contractors (HMC), where due to all kinds of factors, purchasing becomes a department which increasingly impact HMC's financial and operational performance.

This project originates from the perceived high costs for direct acquisition and processing of PR's within HMC's purchasing organization. The goal of this study is to find means to decrease these costs. The academic point of departure to cope with this problem is the field of TCO models (e.g. Elram, 1993; Wouters et al., 2005), combined with purchasing portfolio models (e.g. Van Weele, 2005; Olsen and Ellram, 1997; Kraljic, 1983; Bensaou, 1999; Turnbull, 1990), and e-procurement (EP) tools (e.g. Harink, 2003; Jap, 2002; Beall et al., 2003).

1 Business design plan

In this section the basis for this design study is delineated on. First the project background is described, followed by an outline of the focus of this design study. Finally the project approach is described. Which consists of: project steps taken, research methodology and theoretical viewpoint used, and the document's structure will be described here.

1.1 *Project context*

1.1.1 Heerema

The setting for this study is HMC. HMC is part of the Heerema Group. The Heerema Group consists of two divisions, each with a specific role in the activities of the Group:

- Heerema Fabrication; this division concentrates it's activities on building installations for the oil, and gas industry, industrial market, infrastructure market, (glass fiber) piping systems.
- Heerema Marine Contractors (HMC); transports, installs, and removes all types of offshore facilities, these include fixed structures, complex infrastructures and floating facilities, in shallow water, deepwater, and ultra deepwater.

The Heerema Group of company's designs, fabricates, transports, installs, and removes facilities for the exploitation of oil, and gas at sea. The Heerema Group serves

the world's leading international oil companies in the North Sea, the Gulf of Mexico, West Africa, the Far East, and South America.

Individually, these companies work at the forefront of their industries, helping their clients to safely operate at greater depths, and in tougher environments. In daily operations they operate individually. The total workforce of the Heerema group counts over 2,500 employees, who operate around the globe. The Heerema Group has offices and production locations in: Houston, Port Fourchon (Louisiana), Kuala Lumpur, London, Hartlepool, Perth, Rio de Janeiro, Mexico city, Perth Falomo Lagos (Nigeria), Zwijndrecht, Nieuwdorp/Vlissingen, Zwijndrecht, and Leiden (See Figure 3).

Figure 3: Office locations Heerema Group

1.1.2 Heerema Marine Contractors

HMC is one of the major global players in the field of installation and decommissioning of offshore platforms, and deep sea pipe-lay projects world wide. HMC's main activities can be divided into the following categories:

- Deep water construction; construction, engineering, planning and installation of sub sea structures. Think of mooring systems, pipelines and floating oil production facilities.
- Decommissioning and removal activities which include all operations associated with removing and tearing down offshore constructions, especially oil and gas installations.
- Heavy lifting; these activities include all operations that require the lift capacity and services of the three crane vessels. Usually these are offshore lifting operations where platforms, or other structures have to be lifted in place, but also projects like the pillar for the Erasmus bridge in Rotterdam is performed by the Thialf. The Thialf is HMC's largest vessel and is the world's largest crane vessel with a capacity of 14.000 metric tons of lifting.

- Float-over operations are put into action in cases where the required equipment is beyond existing crane vessel capacities and availability.

The BPSP for this master thesis will take place at HMC's head office in Leiden, where the central procurement department of HMC is located. Next to this central procurement office, HMC has operational procurement departments located in: Houston, Port Fourchon (Louisiana), Mexico City and Perth.

1.1.3 Industry trends affecting HMC

International oil and gas companies like Shell, BP, Chevron, and others tend to use more and more Engineering, Procurement, and Fabrication/Installation and Commissioning (EPIC) contracts. Even the development of entire production locations are outsourced by oil and gas companies in this manner. HMC as one of the world's leading marine contractors in the offshore oil and gas industry also just recently started contracting projects with oil and gas companies on an EPIC basis.

Currently the amount of procured materials and services at HMC [illegible] $ 650 M (Milion) annually. HMC expects that due to the growth in their regular activities and by the growth due to EPIC projects this fig[illegible]xceed $ 1.200 M in 2009. Hence, due to EPIC contracts HMC has to execute tasks, or deliver installations which do not belong to their core business, therefore those items will for the largest portion being outsourced and consequently will increase spend at HMC.

1.1.4 HMC's procurement department

This BPSP will be conducted at HMC's central procurement department. To provide the reader with a good notion of the organization a thorough description of this department is supplied here.

HMC's procurement department is organized around five functional areas or sections, namely (See also Figure 4 on page 3):

- EPIC section is located, and operates separate from the rest of the purchasing department. It has its own specific needs when it comes to goods, equipment, and services it needs to acquire, for the EPIC projects.
- New Build Vessel section's task is to acquire al goods, equipment, and services needed to build HMC's new (and worlds largest) crane vessel, and a new barge which is currently being build in Japan.
- The floating equipment section subcontracts floating equipment when specific, or additional tugs, barges, and other vessels are needed for execution of certain projects.
- Purchasing, procures all goods, equipment, and services for the operations, and maintenance of the three main crane vessels and its support vessels.
- The subcontracting section executes all subcontracting activities which are required to execute projects, fabrication of materials, and equipment.

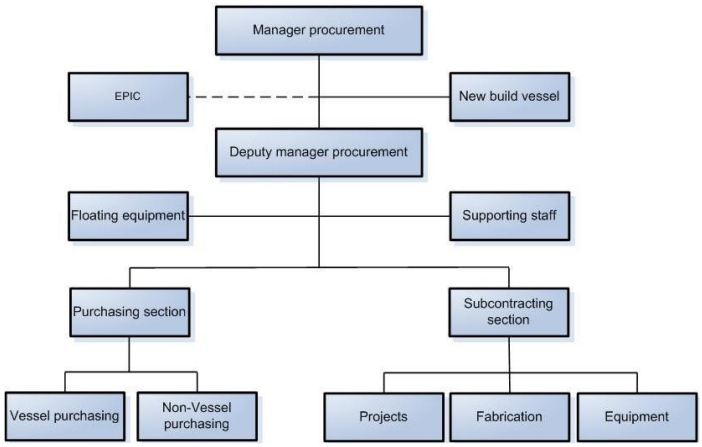

Figure 4: Organizational chart HMC's procurement department

HMC has a clear vision for the future of the company, and it reads as follows; "*By any measure, to be and to be recognized as the best offshore construction contractor in the world" (http://hmc.heerema.com/ @ 14-02-2008)*. This vision is also the basis for the procurement department's vision which is; "*To be a first class procurement organization, whose reputation and competences are recognized by our clients, our strategic suppliers and our organization"*. The definition of success in this vision is again defined and translated into departmental Key Performance Indicators (KPI), targets, management and control policies. In addition to the KPI's, and targets set by the department there is a company wide program called; DAReWIN. This program is set up with the aim to excel company wide by means of setting specific goals for each department. The five most important goals as set by, and for the procurement department are the following:

As can be red in the first of the above stated 2008 goals for the procurement department, the department's primary goal aims at a considerable diminution in TCO.

This study will support that particular goal by seeking specific ways to cut down on TCO.

EPIC Section

One of HMC's strategic goals is to contract new projects on an EPIC basis. The basis for this goal are the market trends as described before, and the growth in revenues it will supply HMC. HMC is currently employing engineering activities for its first EPIC project which is for the British oil company BP. The project encompasses a framework agreement for up to 4 deepwater projects offshore in Angola's territorial waters in the so-called Block 31.

For EPIC projects the total costs of a project are for a large portion determined by the goods and services needed for executing these projects, since HMC relies in these projects for a larger degree on third party subcontractors and suppliers. Furthermore, for some items which need to be procured for EPIC projects, the lead time of procuring those items lie on the critical path of that project. Due to the high impact on profit of the items, and supply risks associated with them, most of those items can be classified as strategic items within the Kraljic Matrix (Kraljic, 1983). Therefore procurement activities are very strategic activities in these projects.

The contract for HMC's first large EPIC project was not yet fully in place during the start-up phase of this BPSP, therefore this section is out of scope for this project.

New built vessel section

This part of the procurement department is established only for the delicate tasks of procuring all items for the new crane vessel. To give the reader an impression of this project some articles about this vessel are included in Appendix VI: New Built Vessel, and a CAD drawing is depicted in Figure 5 below.

Figure 5: HMC's new crane vessel

Currently, HMC is preparing to let contracts for the supply of diesel engines and thrusters for the new vessel, and has signed a contract with Lloyd's Register for the provisions of certification activities. At this moment most attention is given to the long lead time items which have to be purchased, such as: the cranes, J-lay tower, and engines. When purchasing such items -which are critical for its future operations-, the technical specifications are very important. All items are currently tendered (together

with long-term maintenance contracts) and a thorough T.C.O. analysis is conducted for each item to define the best deal for the long term. Since, this department is only temporary operational and works on a project basis, the decision has been made not to focus on this department.

Floating equipment group

The section floating equipment of the purchasing department contracts floating equipment needed to assist in the execution of HMC's operations. Equipment which is contracted for HMC's projects are: tug vessels, barges, supply vessels, accommodation vessels, and heavy transport vessels. The need for floating equipment is identified by the operations department where one employee of the procurement department is located to contract parties to fulfill this need. Until recently, procurement activities around floating equipment were fully coordinated by the operations department. The decision was recently made to centrally coordinate these activities by the procurement department.

Purchasing section

The purchasing section, procures all items which are directly related to one of the crane vessels, support vessels, items related to projects or departments. Items range from new boots for the crew, to a new engine, or fuel. This section mainly purchases goods, and equipment. Services are rarely purchased by this section.

In the set up of the section there has been made a distinction between vessel and non vessel procurement. This subdivision has been made since both splits of the portfolio are perceived to be considerably different in nature (location of the needs, associated departments, technical aspects, vendors, etc.).

Vessel purchasing group

As the name already suggests most PR's for this section originate on board of one of the vessels. Beside the PR's from the vessels, or Equipment Management (EM) department identify items which need to be acquired for operations of the vessels. On board the initial need for an item is most often identified by a (chief) storekeeper, or an engineer, and then the PR is approved by the chief engineer, captain, or superintendent.

Examples of items purchased by this section are: lubricants, steel, engine parts, slings, steel cables, tools, office supplies (ship only), personal security equipment, and clothing, etc. The variety and number of items bought by this department is extensive, and the consumption rate of most of the articles purchased by this section is almost not to predict. Furthermore a lot of these items can not be linked to certain projects. Therefore a large portion of the items purchased by this section can be defined as Maintenance, Repair and Operations (MRO) items (Van Weele, 2005).

Non-Vessel purchasing group

The PR's for the non vessel generated purchases are mainly initiated by projects, the Operations (OPS) Human Resources department (HR), and occasionally from other

departments. Typical items are: hoisting cables, anchor wires, fuel for all vessels, manpower, and project specials. Currently 2 FTE execute all non vessel generated purchases. Items bought by this group have typical values ranging between $1 K (K=thousand) and $ 5 M. Among all items, especially fuel and crane/anchor cables are very expensive items

From all goods, equipment, and services procured by non vessel generated purchasing, office supplies, and computer equipment are not all centrally purchased by the purchasing department. Parts of the office supplies are purchased by the department general affaires. Parts of the software and hardware for the Information System (IS) department are bought directly by that particular department. Hence, these two groups of procurement items are out of this study's scope.

Subcontracting section

This section receives its internal requests mostly from Equipment Management (EM) and project teams. The latter is responsible for the execution of the diverse projects and the associated budgets. The subcontracting sections contracts services needed for executing the projects by one of the vessels, services for maintenance of equipment or the vessels, and rental of equipment.

Within this department a split has been made between services, rental equipment, and technical equipment which need to be fabricated on specifications. These different splits will be treated separately below.

Subcontracting fabrication (technical equipment) group

The subcontracting fabrication group subcontracts fabrication and installation of installations aids such as: grillages, sea fastenings, hoisting equipment (spreader bars, slings, hang off points, etc.). Specifications for all items which have to be subcontracted are defined by project teams.

Beside the procurement of new materials there is a pool of used equipment which is suited for reuse. When equipment is removed from the vessel and it is suited for reuse, the equipment will be transported to one of the storage sites in: Vlissingen (NL), or Fourchon (USA). When equipment needs to be adjusted before it can be reused for a certain job, subcontracting fabrication will also arrange this. Furthermore the floating equipment – especially barges- have to be revised after they have been used for a job. Activities involved in this are: painting, grinding, burning, cutting, welding, etc., these are also subcontracted by that department.

Subcontracting equipment and services group

This group has to deal subcontracts for services, and equipment. In general only a very limited number of vendors are equipped to deliver the service, or equipment. An illustrative example is the ballasting of SPAR platforms, for these services only 1 party has the capacity to undertake that specific operation and deliver the qualified goods.

Contracts for both Master Service Agreements (MSA's) and project contracts are awarded via a tender process. Annually 70 of such tenders are held with contract values ranging from $150 K up to $ 10 M. As delineated before goal is to capture as much of the recurring subcontracts in MSA's, examples of service MSA's currently in place are: positioning and survey, welding, Automatic Ultrasonic welding Tests (AUT's), scaffolding. Equipment which is highly specialised, or only needed on very specific projects is hired. Examples of such equipment are: Deep Sea Hammers, hydraulic pumps, etc.

The area in which the vessels operate, determines for a large degree the availability of vendors for certain services, and goods. This especially counts for services, since for a large portion of the services an onshore basis is needed to support these operations.

1.2 *Problem definition*

The question of this BPSP originates from HMC's notion that more innovative ways of purchasing can save on direct purchasing as well as process costs. The question is therefore, *what new purchasing methods can decrease Total Cost of Ownership within Heerema Marine Contractors*. New purchasing methods in this question are procurement methods and tools which are currently not utilized, with special emphasis on e-procurement tools.

In order to get a better picture of the current situation and focus on the most promising areas a preliminary study will be conducted to identify the most important cost drivers, processes, and methods used to acquire materials, equipment, manpower, and services. This information then will be used to further concentrate the focus of this study, and design a solution and implementation plan for coping with the problem at hand.

Summarizing, the questions which needs to be answered during this study in a sequential order, are:

- What are the most important cost drivers, processes, and methods used to acquire materials, equipment, manpower, and on a departmental level? What section and group should be focused on?
- What evidence can be gathered to cross validate finding, and what disconfirms findings from the departmental analysis for a specific division and group?
- What solutions could be promising for HMC considering the problems at hand? Furthermore, what is the most promising solution taking into account the ROI of each solution?
- How should the most promising solution look like in detail?
- What is the best manner to implement this solution in the current situation at HMC?

The solution design will be designed for HMC. Therefore the solution design should comply with the requirements as defined by HMC. These requirements are the following:

Functional requirements:

- Realization of the solution should solve the business problem: In this business case it is reducing TCO, by means of innovative procurement tools.
- The benefits should exceed the costs: The anticipated Return On Investments (ROI) of a solution should be as high as possible and at least exceed 1.

User requirements:

- The people involved should have the competences to work in the new situation, and with the new tools, procedures, etc.
- The new system should be user-friendly.

Boundary conditions:

- The system should comply with HMC's business ethics, legal requirements, including those on safety and health (See Appendix VII: HMC's supplier code of conduct)
- The system should fit within the present company culture.

Design restrictions:

- The project's time span should not exceed 18 months. The duration of 18 months has been set as a first bound for a change project, and has been determined as a result of the experience of my supervisors.
- Executing of the project and maintenance of the new system should not cost more than $ 200 K on an annual basis. This restriction has been set, since this amount falls within spare capacity of the current budget. When the costs of the project are excessively higher, budget has to be made available beyond the procurement department's boundaries.
- The realization of the solution should impact as little as possible the present business processes. This requirement is not very exhaustive since it is hard to describe on what exact levels a potential solution will impact. Especially, since no potential solutions are known beforehand.

1.3 Project approach

1.3.1 Project steps

Since this project is aimed at solving a business problem the following stages can be identified within this project (Van Strien, 1997):

- Problem mess; this is the start of the project.
- Problem definition; the problem definition is initially identified and defined by the company principal. In a later stage this definition could possibly change due to the input of new information, or new insights. Hence, the problem definition is the driver of the BPS project.
- Analysis and diagnosis; this step is the most analytical and research oriented part of the project.
- Plan of action; in this stage one, or more solutions are designed to cope with the identified problem. Furthermore a change plan is made to incorporate the solution properly.
- Intervention; the change plan is implemented in daily business. This will be out of scope for this project.

- Evaluation; at a point in time which is most appropriate considering time constraints etc. the process until that point is evaluated to check what future steps have to be undertaken in order to maximally gain from the redesign. Also this step is out of the scope for this project.

The sequential steps of the regulative cycle by Van Strien (1997) can be visualized, and is shown in the square box in Figure 6 below. After all steps have been conducted within the regulative cycle, the reflective cycle (the large cycle in Figure 6) will be followed. Goal is to reflect on findings from the regulative cycle to come up with business rules which are applicable beyond the case study (Van Aken, 2004).

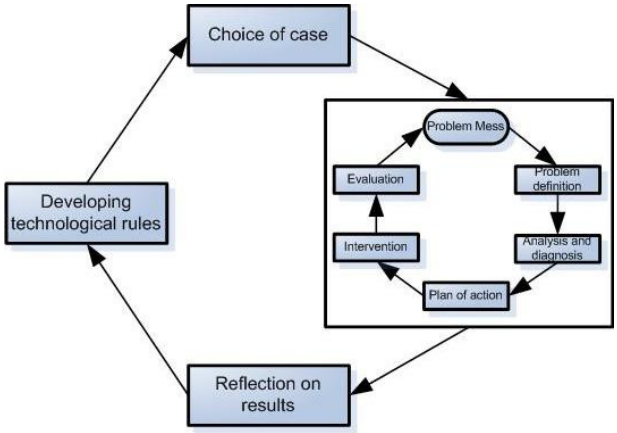

Figure 6: The reflective cycle (Van Aken, 2004) in combination with the regulative cycle (Van Strien, 1997)

In order to fulfill the above stated objectives a number of steps have to be conducted. These project steps are stated in Table 15 (in Appendix II: Project approach). Each step is placed in a project phase from the regulative cycle (Van Strien, 1997) (See the third column in Table 15 in Appendix II: Project approach).

Verschuren and Doorewaard (2007) suggest drawing a research model for each research, or design study which one has planned to undertake. A research model helps to clearly depict the sequence, and interrelation of steps which one has planed to undertake in a study. The research model for this study is shown in Figure 26 in Appendix II: Project approach.

1.3.2 Research methodology

Throughout this study various research methods are used to collect data and draw validated conclusions. See Table 16 (in Appendix II: Project approach) for an overview of methodologies to gather information for case studies, together with the strengths and weaknesses of these methods (Yin, 1994).In this situation interviews, in combination with the consultation of archival records and documentation seem to be the most promising research methodology.

When using interviews a distinction can be made between three types of interview techniques (Verschuren and Doorewaard, 2007):

- *Structured interviews* are characterized by a formalized, limited set of most often ended questions. Main advantages of this method are: interviewees are presented with exactly the same questions in the same order. This ensures that answers can be reliably aggregated and that comparisons can be made with confidence between sample subgroups, or between different survey periods.
- *Oppositely unstructured interviews* have no pre-set range of questions and answers for each interviewee. The largest benefit of this method is that the richest information is gathered and things can be explored very efficiently.
- *Semi-structured interviews* can be typified by a set of predefined questions and room for respondents to supply additional information and the interviewee to ask additional questions. This methodology spurs accumulation of rich information by listening to how each individual responds to open questions.

The interview type which fits this study best is the semi-structured type of interviewing, primarily because this mode of interviewing provides the respondents with the opportunity to recall freely and take up a direction in the response on a question. Furthermore the responses can be followed up with more specific questions from the interviewer (Keats, 2000). Keats (2000) states that an interviewer should, during the interview, be open minded for new questions and approaches on the problem in order not to lock the interviewer and the interviewee into a specific line of argument. However, the interviewer should be attentive that no digression into irrelevant details occurs during the interview.

In the first stage unstructured interviews are held with multiple key employees from each section: section heads, managers, lead buyers, buyers, subcontract coordinators. Goal of this stage in the design study is to gather information on internal processes taking place, detecting problem areas, and identify the most promising focus of this design study. The interviews are held in a semi-structured manner by taking key elements where this study is based on into account (TCO). Findings from the interviews are registered and grouped according to the TCO approach as suggested in chapter 2. Findings from the interviews will be combined and verified by consulting archival records. When all this data will be analyzed and documented, the section heads are asked to supply feedback, which is consequently processed in order to draw validated conclusions.

When the focus of the study is determined, the causes and effects of the problems will be explored and validated with additional interviews, observations, and supplementary consultation of archival records. The interviews will also be of a semi-structured type. Since there are also employees involved in the process who are stationed onboard of the vessels, and abroad, therefore a questionnaire has been designed for the purpose of extracting data from these sources (See Appendix IV: Questionnaire and support letter). In addition, all relevant internal documents, reports, internal ERP systems, databases, etc are used as a source of information. Stakeholders are asked for feedback on findings, results, and conclusions drawn from the different data sources.

Aim is to cross validate the causes and effects as much as possible by methodological triangulation (Denzin, 1970). See Table 17 in Appendix II: Project approach for the

different types of triangulation. Due to the different levels whereon data will be gathered and analyzed (departmental level and within a specific section and group), this study can be tagged as a multi-level case study (Verschuren and Doorewaard, 2007).

Furthermore a desk study is executed to identify means to deal with issues at hand. To gain sufficient insights in the most relevant findings within the field of purchasing, both relevant literature from academic journals, and business reports (like: Aberdeen, Accenture, IPSeRA, CAPS Research, NEVI) are used. Literature is selected on relevance, quality, number of citations, and age. Moreover, interviews are conducted at different companies who operate in the same industry, and operate in a similar manner to gain insight in potential improvements/advanced procurement methods. In addition visits to different vendors and trade fairs are made to gain insight in what kind of vendors HMC conducts business with, and what kind of TCO reductions can possibly be realized.

Last but not least common sense and logical reasoning (deduction, induction and abduction) are used to combine findings, come up with directions for change, and design a change plan to cope with the business problem(s) at hand.

1.3.3 Theoretical viewpoints

In order to effectively cope with the problem at hand, the problem will be handled with in the light of a suitable theoretical foundation. As discussed this project's goal is to find ways to decrease purchase related costs within HMC. The most suitable theoretical basis for this question most likely can be found in purchasing literature.

In Figure 7 a conceptual project design is presented for the problem faced by Heerema. This conceptual project design explicates the project subject as well as the theoretical perspective that will be applied in this project.

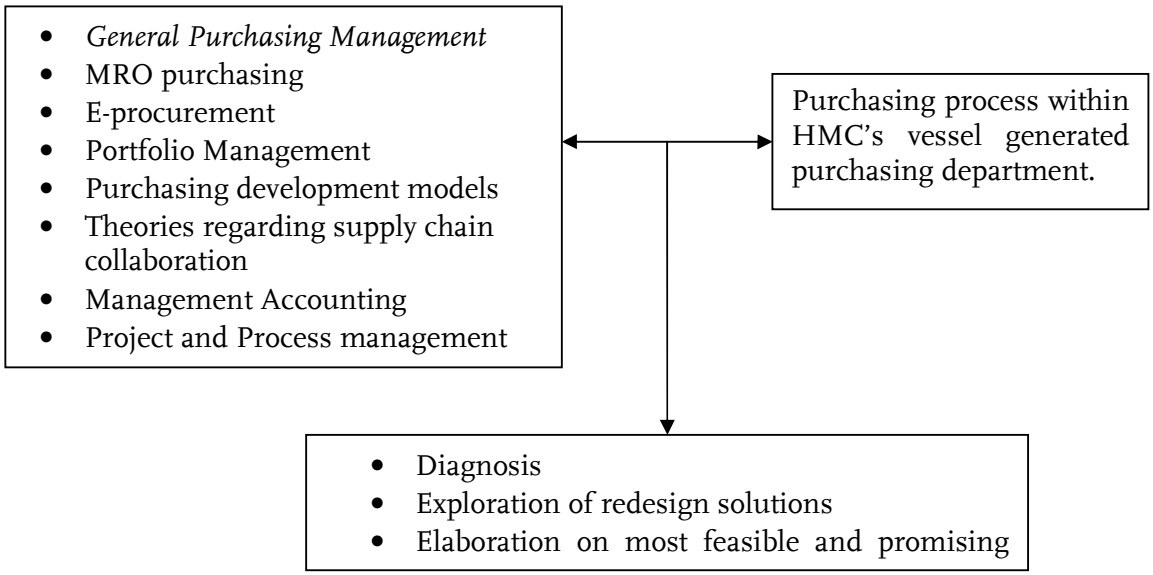

Figure 7: Theoretical viewpoints

1.3.4 Document structure

The project steps which are carried out will be discussed in this final report. The following distribution has been made to delineate on the steps:

Chapter 1: Business design plan.
Chapter 2: Theoretical foundation.
Chapter 3: Empirical analysis and diagnosis: Procurement process, key data, and associated costs within HMC's procurement department
Chapter 4: Conceptual Design: Analyze findings from the former step, and based on that, design strategies for improvement. Selection of the most promising direction for change
Chapter 5: Solution Design: The most promising direction for change will be further elaborated on.
Chapter 6: Change plan: Design of a detailed change and implementation plan for the most promising direction for change.
Chapter 7: Conclusions, evaluation and termination of the project.

2 Theoretical foundation

This chapter aims to be conceptual; it treats findings from research and management studies, including theoretical discussions about the main issues under study. This chapter starts of with an introduction of business to business procurement and procurement processes where special emphasis will be placed on MRO purchasing. This is followed by an introduction into the theory and practices of TCO models. Thereafter theories on product and supplier classification will be treated. This chapter ends with the delineation on possible means which can reduce TCO in MRO purchasing. Special attention will be given to electronic means of TCO reduction. Particularly e-reversed auctioning as a mean for reducing direct purchasing costs will be treated into detail.

2.1 Procurement and procurement processes

Like many definitions in management literature one can find many definitions of a single concept, all varying on certain small aspects. This is also the case for the concept procurement. For practical reasons the author of this thesis choose for the definition by Van Weele (2005) who defines purchasing as; "obtaining from external sources all goods, services, capabilities and company's primary and support activities at the most favourable conditions".

The procurement process can be divided in multiple stages and modelled in different manners. One of the most well known and widely utilized purchasing process models is the model developed by Van Weele (2005). Van Weele divided the purchasing process in six steps: determining specifications, selecting suppliers, contracting, ordering, expediting/evaluation, and follow-up/evaluation. Furthermore Van Weele (2005) divided the purchasing function into two distinct type of processes; a tactical and order/operational process (See Figure 8).

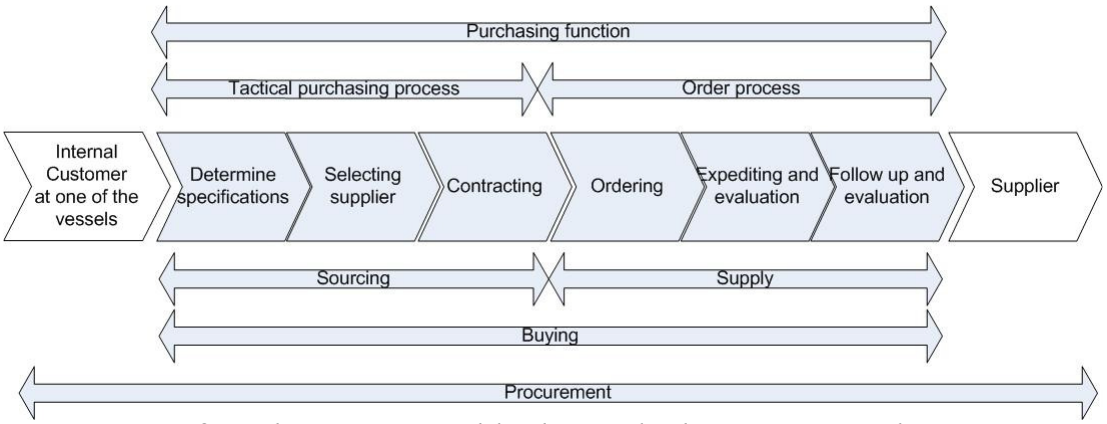

Figure 8: Purchasing process model and some related concepts (Van Weele, 2005)

This study is all about business to business purchasing; the buying and selling of goods and services between companies (Van Weele, 2005; Noyce, 2002). When business-to-business purchasing is compared to business-to-consumer procurement, it differs on various levels (Van Weele, 2005):

- The buying objective of companies is to enable production rather than personal need satisfaction (hedonism).
- Business's buying motives are mainly rational instead of emotionally driven.
- Professional purchases are most often executed by men instead of women in consumer purchasing.
- Decisions are made with many persons involved instead of individually and impulsive.
- Market knowledge of industrial buyers is most often large while consumers most often have limited product and market knowledge.
- Order sizes from companies are most often much larger than from consumers.
- Industrial demand can fluctuate heavily, while consumer demand is relatively stable.
- Price elasticity in industrial markets is rather inelastic compared to consumer markets.
- The number of industrial customers is limited compared to consumer markets,
- Business customers are sometimes geographically concentrated while consumers usually have a large geographic spread.

Since this study's focal point will be business purchases, and even more specifically on maintenance, repair, and operations (MRO) purchasing which is also termed indirect procurement. Indirect procurement items concern all items and services that are not directly part of a finished product. Compared to production-oriented procurement, the range of items of indirect purchasing is much broader. This also implicates that MRO items are acquired via a much larger amount of vendors, and indirect purchasing is much more complicated to manage when compared to direct procurement. Indirect purchases normally include a broad variety of items, ranging from "simple" office products to parts for maintenance, repair, and operations, such as lubricants or spare parts, to complex construction-related items and to various services. Purchases usually occur on an infrequent basis and demand is difficult, if not impossible, to forecast. Normally indirect purchasing activities are executed by non-purchasing experts, as well as by the central purchasing unit (Cox et al., 2005; Van Weele, 2005; Le Sueur and Dale, 1998).

Recently, spend on MRO received increased attention when it comes to managing this type of purchasing within organizations (Cox et al., 2005). This is not without reasons since in general indirect purchase expenditures accounts for 20 up to 50 percent of all spend and 70 to 90 percent of all Purchase Orders (PO's), shipment expenses, and invoice processed (Barry, 1999). Furthermore, among others Carter et al. (2003) showed that significant improvements can be made in the indirect spend portfolio and reduce costs and raise service levels, when this type of procurement is managed properly.

2.2 Total Cost Models

TCO can be seen as an application of Activity Based Costing (ABC) and is a concept which is used to describe all costs associated with the acquisition, use, maintenance, decommissioning, recycling of a good or service in the entire supply chain (Elram,

1993; Degraeve and Roodhooft, 1999; Degraeve et al., 2005; Roodhooft and Konings, 1996; Wouters, et al., 2005). The TCO of procured goods and services represent the true costs which are directly and indirectly incurred by procuring a particular item or service. Furthermore TCO is argued to be an important instrument in supporting a more strategic focus on purchasing and supply chain management (Van Weele 2005; Wouters et al., 2005).

Elram (1993), concluded from her study on TCO practices within a wide variety of companies and industries that at minimum any TCO approach should include: transportation costs, receiving costs, quality costs (inspection, rework, and rejection costs), purchasing administrative expenses, including management time, and of course; the price of the purchased item. These aspects will also be taken into account in this study. Elram (1993) also identified what the major advantages are for companies who actively deploy a TCO approach in their procurement management practices:

- Improving the quantitative measurement of supplier performance, e.g. measuring the results of supplier performance improvement/quality improvement efforts, benchmarking, etc.
- Improved decision making by easy to compare and complete data on important cost issues. TCO forces procurement officers to evaluate vendors subjectively and thus provide a good basis for supplier selection decisions (Roodhooft and Konings, 1997).
- Due to the solid data which is gathered and can be analyzed, it is easier to communicate to suppliers aspects regarding their performance. It also presents a way to get internal stakeholders involved in purchasing decisions by providing data, or identifying relevant cost considerations.
- The availability of data and the depth of the TCO approach provide important insights and deeper understanding into the true performance of suppliers (and their goods or services). TCO also helps purchasing personnel to develop awareness and insight in the significant non-price factors that affect their firm in the case of certain buys. These insights can help in negotiations, and in determining which non-price cost elements a supplier should provide, and which can be foregone or obtained more economically elsewhere. Furthermore, TCO provides a better understanding of purchase decisions by taking a long-term, big picture approach. It looks beyond price to explore how purchasing activity affects the firm's total costs both today and in the future.
- A final benefit of TCO is that it enables to identify cost savings opportunities. Therefore TCO is a good basis for firms striving to continuously improve some aspect of the firm's or the supplier's operations.

As revealed by Elram (1993) one of the largest benefits of TCO is the increased insight in the costs made per (group of) item or service. A TCO based approach therefore could be a good basis for analysing where the largest gains can be made in cost reduction programs.

2.3 *Product and supplier classification*

Supplier portfolios are suitable tools for overall supplier relationship management. Problems, however, arise when a certain supplier delivers considerably different types of products or services. For instance, a certain supplier can deliver components falling into different categories, so different purchasing methods are appropriate and should be applied considering the nature of the products. This problem can be obviated by categorizing purchased products instead of suppliers. A product classification approach highly supports the idea that a supplier should be evaluated based on the products or services, and not as a firm (Cousins, 2002).

One of the most established and widely adopted models to differentiate products in order to find suitable purchasing strategies is the Kraljic matrix (Kraljic, 1983). Due to its simplicity and wide adoption of this model the author choose to use Kraljic model complemented with additional studies from Van Weele (2005), Gelderman and Van Weele (2003), Nellore and Söderquist (2000) as a mean for product and supplier classification.

Kraljic classified products on two dimensions: first, product's impact on financial result, and secondly, the supply risk/complexity of the supply market. The first dimension explains the product's/supplier's impact on the company's financial results. If a company's costs are for a large degree determined by purchased goods, and/or services this means that the purchases have a large impact on the profit of the company. Also if the expenditures of materials or services are a large portion of the total costs of a product or service, it means that a small change in these costs already has a large impact on profit, and profit margins. This dimension can be defined in different manners: the volume of purchases, percentage of total purchase costs, or impact on product quality or business growth. The second dimension is the complexity of the supply market, and can be describes as the risks that are associated with the product. This property can be assessed in terms of availability of the products, number of suppliers, competitive demand, make-or-buy opportunities, storage risks and substitution possibilities (Van Weele, 2005; Kraljic, 1983). Kraljic (1983) divided both axes in two which resulted in a two-by-two matrix (See the top matrix in Figure 9). The same can be done for suppliers, a matrix for classifying suppliers is provided in the bottom matrix in Figure 9.

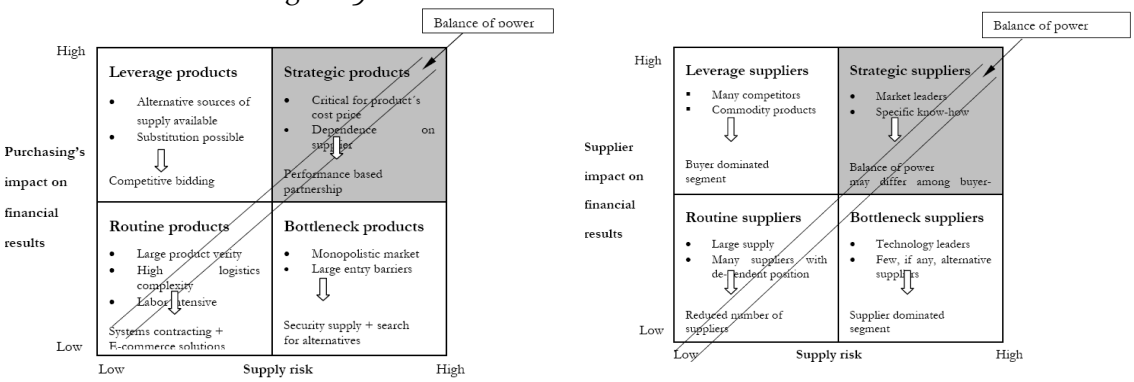

Figure 9: Kraljic Matrix (adopted from: Kraljic, 1983, and Van Weele, 2005)

Kraljic (1983) Van Weele (2005), Gelderman and Van Weele (2003), Nellore and Söderquist (2000) conclude that goods in different quadrants have to be treated differently. For companies to determine the most optimal purchasing strategy the company's purchasing portfolio can be analyzed according to the above mentioned criteria. By analysing the products on these two dimensions, the company can place all its purchased products on the two dimensions and into the four categories: strategic, bottle neck, routine and leverage products. The company will then be able to determine which type of purchasing strategy the company should follow for each specific product and supplier.

As a sequential step - after the purchase portfolio has been analyzed- the company at stake could be willing to change the positions of (groups) of items within the matrix. Then the company should take the following aspects into account when considering consecutive actions to advance their procurement position:

- The company's business strategy.
- Current and future supply market(s).
- Performance capacities and intentions of (individual) suppliers.

Companies have two choices when it comes to positioning purchasing goods: holding the items in the same position in the matrix or undertake actions in order to pursue other positions in the matrix. Gelderman and Van Weele (2003) designed a conceptual model with potential strategic directions in the Kraljic matrix as a result of their study on measurement issues and strategic directions in Kraljic's purchasing portfolio model. The suggested strategic directsion are depicted in Figure 10.

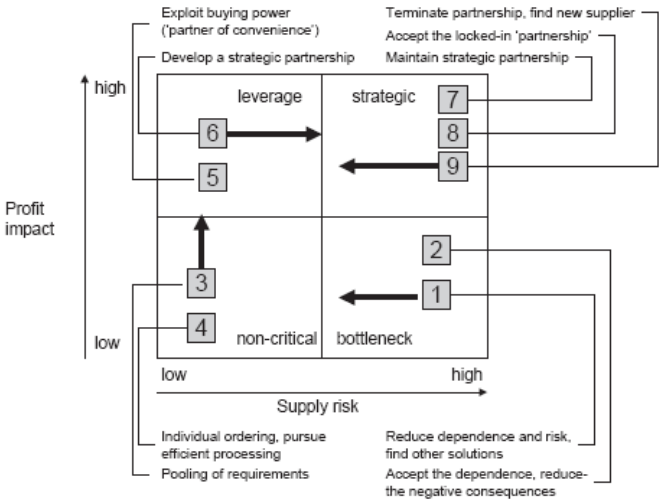

Figure 10: Strategic directions for purchasing categories (Source: Gelderman and Van Weele, 2003)

2.4 Managing MRO purchasing

As stated earlier, acquisition expenditures are not the only aspects which make up the total costs incurred for the operation of a company, but can make up a large portion of total costs incurred by a company. Furthermore purchasing decisions not only bear

upon the direct purchasing costs, but also on indirect costs such as quality assurance, administration, transport, inventory holding costs, and payment, to name a few. Thus decisions made during the acquisition process have a large impact on a company's costs and thus profitability. TCO analysis is a tool for analyzing the resources consumed in performing the purchasing-related activities and measures all the costs and benefits involved in the possession, utilization and elimination of goods and services. A TCO approach is also an appropriate approach for analyzing the indirect spend (E.g. Dubois, 2003; Barry et al., 1996). A TCO framework will be used for analyzing what effects different procurement management instruments have.

Considering findings in academic literature the following topics will be treated for reducing TCO in MRO purchasing (Bechtel, 1997; Barry et al., 1996; Gebauer and Segev, 2000):

- Supply base reduction, supplier cooperation and vendor management: Cross enterprise costs reduction and suppliers selected based on more than direct acquisition costs only.
- (Multi year) Frame agreements: direct costs reduction, quality improvement.
- Automation of purchasing processes and E-procurement (EP) tools (catalogue systems, EDI, eRAs).

2.4.1 Supply base reduction, supplier cooperation and vendor management

The necessity of reducing the supply base has been highlighted by many researchers (e.g., Cousins, 1999; Dowlatshahi, 2000). Dowlatshahi (2000) cites three reasons for the need for supply base reduction:

1. A small supply base reduces supplier development costs.
2. Close and workable relationships can only be developed with a limited number of suppliers.
3. Substantial business can be rewarded to only a limited number of suppliers.

Established economic wisdom suggests that the more suppliers are available in a given market place, the more competitive the price becomes. This notion seems to be disproved by firms who execute large supplier reduction campaigns (Cousins, 1999). The main motivation for companies to start such campaigns appears to be price reductions. Savings of between 15-20% have been reported. Price reductions are most often achieved in the short term by operating a leveraged approach to supply management, and reducing administrative burden. Nevertheless, most often due to the leveraged approach those companies were forced into highly dependent, long-term relationships, without the knowledge of how to manage them. When companies utilize this approach they run the risk that after a certain period, suppliers may increase prices and decrease service levels when the supplier realise that they are in a dependent relationships. Furthermore supplier reduction programs can have other important cost implications such as managerial and strategic exposure costs. By single sourcing or by delegating authority to one major provider, the risk to the organization may be increased. These adverse effects are the main reasons why a large portion of companies who first reduce supply bases, later consider increasing the supply base (Cousins,

1999). Cousins (1999) studied the effects of supply base reduction programs: he concluded that firms need to take a total cost perspective and consider long term effects in such programs, to overcome most of these above mentioned problems. As a result from his study he developed a conceptual view on return rates of both modes of "cooperation" (See Figure 11).

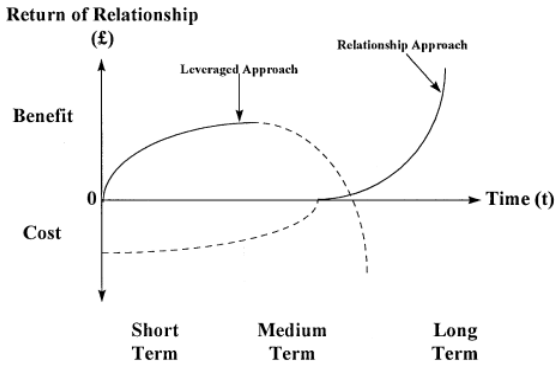

Figure 11: Conceptual view of relationship return rates (Cousins, 1999).

As Figure 11 depicts, on the long run a relational approach with less suppliers is more beneficial compared to a leveraged approach which is most beneficial on the short run (Cousins, 1999). Generally the prerequisite for developing strong buyer-supplier relationships is to have a small number of suppliers. In most organizations the number of registered suppliers is large, but only a limited portion of the supplier base receives the largest portion of orders year after year (Kauffman and Leszczyc, 2005).

From these findings in academic literature one can conclude that in general, a balance needs to be found for the optimal number of suppliers, a leverage approach (bundling supply into discrete categories, tough negotiations) and the strategic consequences such an approach can have for both the buyer and supplier on the short, medium, and long term.

Vendor assessment can be defined as the formal process that combines a vendor selection stage (the decision on which suppliers best suits the customer's requirements) with a vendor performance measurement stage (monitoring the performance of supplier(s) and compare it with the customer's expected levels of performance and their peers) (Gregory, 1986; Timmerman, 1986; Monczka and Trecha, 1988).

The transition from assessment to development involves a simple step: the information obtained by the customer during the process of assessment of the supplier can be communicated to the vendor in order to improve his performance. This presumes that they buying party is able to interpret the information in a suitable way, and then communicate it effectively to the supplier, and will take a leading role in the development process.

Lamming et al. (1996) studied the effects vendor management and vendor development has on different large companies in different industries. The outcome of this study was that the most important benefits were: improved overall quality, better all-round service, improved delivery performance, improved relationships and reduced direct acquisition costs.

Degraeve et al. (2000), concluded in his study on vendor assessment methods that, an approach which takes into account multiple aspects outperform models with a single item. Furthermore Degraeve et al. (2000) found that total cost approaches outperform rating models by objectifying the supplier selection process, and models where information from the entire supply chain is used provides better input for all models.

Considering the findings in the light of the TCO framework; the largest gains can be made in quality improvements and decreasing administrative costs, when actively reducing supplier base, supplier cooperation and vendor management activities.

2.4.2 Frame agreements, rate contracts and spend consolidation

An alternative way of handling internal PR is the use of frame agreements or rate contracts. Frame agreements or rate contracts are contracts wherein a part of a company's purchase portfolio has been consolidated and awarded to one vendor (Andersen et al., 1999; Mohanty and Deshmukh, 2000; Van Weele, 2005). Elements where typically is dealt with in frame agreements are: prices, service levels, quality, specifications of the products, prices, price indices, contract period, and invoicing.

Sourcing via frame agreements or rate contracts can have multiple advantages compared to sourcing the same items via single contracts/PO's (Andersen et al., 1999; Mohanty and Deshmukh, 2000):

- By consolidating spend into frame agreements groups of items can sourced against lower direct acquisition costs.
- Decrease in administrative burden; as more and more items are ordered under rate contracts, time spend on inquiries and quotations is saved since they most offer simpler purchasing procedures, the need for supplier searches is eliminated, and also a fixed, or even decreasing, price for defined parts is guaranteed.
- By guaranteeing supply by means of "frame agreements" substantial reduction of lead times, and increase in quality can realized as well.
- Frame agreements can also be valuable input for planning and estimating project costs.

During this study a Dutch offshore dredging company called DMCC[3] was interviewed, who also used "frame agreements" as a purchasing tool. DMCC used frame agreements for items which were sourced on a frequent basis, those were critical, as well as non critical items (office supplies). DMCC used frame agreements mainly as a

[3] 'DMCC' is a fictive name for a global player in the Dredging and Offshore Marine Contracting industry.

tool for reducing administrative costs and direct acquisition costs by bundling and pooling spend into one contract. At DMCC a so called "contract manager" was responsible for managing these long term contracts.

As delineated above the largest benefits of frame agreements when it comes to reducing TCO lie in the potential of reducing administrative burden, reducing direct costs and improving quality.

2.4.3 E-procurement in MRO purchasing

In most companies direct purchasing is highly developed and automated. Besides the utilization of extensive buying procedures, IT-systems (information technology) have a long history in direct purchasing. IT systems for instance EDI (electronic data interchange) applications enabled JIT (Just-In-Time) supply chain management methods. Where operations are typically triggered through demand forecasting, via BOM's (Bill Of Materials), and processed in Material Requirements Planning (MRP) or Enterprise Resource Planning (ERP) systems (Kim and Shunk, 2004; Van Weele, 2005).

When one compares the general advancement of utilized buying methods of direct and indirect procurement one can state that indirect procurement is less advanced. This notion comes from the fact that in general indirect procurement received far less attention on an organizational level, resulting in little process standardization, and most procurement activities take place outside the procurement department. Furthermore IT systems are less often utilized in MRO procurement activities resulting in a majority of paper based activities (Kim and Shunk, 2004; Van Weele, 2005).

Due to the advent of less expensive and flexible systems, companies saw ways to realize savings in the area of indirect purchasing. Most often these systems are internet based procurement tools, or as it is most commonly abbreviated: EP tools. Although there is much literature available on the topic of EP there is little consensus about how to define EP (e.g. Gunasekaran and Gnai, 2007; Reunis, 2007). Grieger (2003) described this situation as a "jargon jungle". Despite the lack of consistency in the use of one definition of EP, authors agree that EP is about using internet technology in the purchasing process (e.g. (Hawking et al., 2004; Harink, 2004; Van Weele, 2005; Reunis, 2007). Therefore the author of this paper chooses to define EP as; "*internet technology supported procurement*".

The associated benefits of EP can be categorized into two major categories, namely: efficiency and effectiveness (Puschmann and Alt, 2005). The former refers to process, products and inventory savings the latter to proactive management of key data and higher-quality purchasing decisions within organizations. Searching literature on benefits associated with EP reveals the following benefits (Chaffey, 2004; Harink, 2004; Heijboer and Telgen, 2002; Presutti, 2003; Roche, 2001; Wyld, 2002):

- Lowering purchase prices.
- Shorter purchasing cycle time.
- Shortened Process cycle times.
- Improving information

- Reduced administration costs.
- Lowering inventory levels.
- Elimination of administrative errors.
- Improvements in the payment process.
- Enhanced inventory management.
- Improved contract compliance.
- Reduced operating & inventory costs.
- Improved market/supply chain transparency.
management (better access to prices from alternative suppliers and summaries of spending).
- Reduction of maverick buying.
- Increased numbers of potential suppliers through lower barriers for market entrance and greater market transparency.
- More time for purchasing professionals to concentrate on tactical and strategic tasks.

In addition to a lot of advantages which are associated with the utilization of EP tools, it is also associated with certain disadvantages. Examples of these adverse effects are (Skjot-Larsen et al., 2003; Nepelski, 2006; Knudsen, 2003; Hawking et al., 2004; Deeter-Schmelz et al., 2001):

- Increase in the number of suppliers which spurs costs associated with transaction management, screening, etc. of suppliers.
- Adversely moderates the possibility to build capabilities via suppliers.
- Hampers new business opportunities via sourcing companies.
- Decrease in supplier loyalty.
- Dependability on supplier's adoption.
- A lack of adoption, resulting in an obsolete expensive tool (negative ROI).

De Boer et al., (2002) developed a conceptual model which depicts direct and indirect impact of various forms of EP on firm's purchasing costs (See Table 20). As can be seen e-ordering systems are well suited to support and automate indirect procurement activities. Resulting in significant efficiencies, time and cost savings at all levels across an enterprise. Proper use and implementation of e-ordering systems (or catalogues systems) can result in self-service transactions for end-user purchasing and reduced maverick buying (De Boer et al., 2002; Kim and Shunk, 2004; Harink, 2004).

	Impact on:				
	The expenditures on purchased items and services directly related to a firm's primary operations.	The expenditures on purchased items and services which are not directly used in the firm's primary operations.	The costs of executing operational purchasing activities, i.e. ordering, expediting and administrative support.	The costs of executing tactical purchasing activities, i.e. setting specifications, selecting suppliers, negotiating and contracting, etc.	The costs of executing strategic purchasing activities, e.g. conducting spend analysis, developing purchasing policies, etc.
E-ordering	.	+ +	+ +	-	(+)
E-sourcing	.	.	.	-	.
E-tendering	.	(-)	.	+	.
E-reversed auctions	+	(+ -)	.	-+	.
E-informing	.	.	(-)	.	+

+	Positive impact
-	Negative impact
()	Litle impact
.	No impact

Table 3: Classification and effects of EP types (De Boer et al., 2002)

Like many others Accenture in 2007 studied the effect of EP tools on process costs. Their findings on cost savings which can be realized in the procurement process of indirect spend with the help of new technologies is presented in Table 4.

	Generate requisition	Obtain approval	Create and place order	Expedite and receive goods	Invoicing	Error Handling	Reconsolidation	Payment	Total	
Manual	$ 16,82	$ 12,91	$ 11,14	$ 4,44	$ 13,52	$ 7,04	$ 22,24	$ 8,89	$ 97,00	100%
EDI (combined with ERP)	$ 5,00	$ 8,54	$ 3,53	$ 11,25	$ 6,71	$ 1,72	$ 4,23	$ 3,64	$ 44,63	46%
Catalogue systems	$ 8,14	$ 2,94	$ 7,44	$ 3,64	$ 6,71	$ 1,72	$ 4,23	$ 3,64	$ 38,47	40%

Table 4: Process costs compared (Source: Accenture, 2007)

The following EP tools will be further delineated on, for the purpose of this design study (since these are thought of to be the most promising in this case):

- EDI (Electronic Data Interchange); reduction of process costs.
- Catalogue systems; reducing process costs.
- eRAs; reducing direct acquisition costs and lead-time.

2.4.3.1 Electronic Data Interchange

Electronic Data Interchange (EDI) is the computer-to-computer interchange of strictly formatted messages that represent documents other than monetary instruments (The National Institute of Standards and Technology, 1996). EDI enables business organizations to efficiently work together, quickly exchanging transaction information in standardized formats. Organizations can establish direct connections to each other through the use of the Internet or indirectly via Value Added Networks (VAN). Setting up EDI links can be initiated by the supplier or the buyer, where both have distinct strategic advantages (Mukhopadhyay and Kekr, 2002). Common applications are the placing of PO's, transmission of delivery plans between the buying company and a vendor, automatically producing PO's according to production planning and BOM's.

The possibilities for saving costs and increasing competitiveness by applying EDI are widely recognized (E.g. Van Weele, 2005, Mukhopadhyay, 2002). Most important benefits of EDI relate to the decrease in human interaction, and materials such as paper documents, faxes, etc. in processing PR's. Even when documents are maintained in parallel with EDI exchange, e.g. printed shipping manifests, electronic exchange and the use of data from that exchange reduces the handling costs of sorting, distributing, organizing, and searching paper documents (Kaefer and Bendoly; 2000, Mukhopadhyay and Kekr, 2002; Van Weele, 2005). Examples of companies who utilize EDI are enormous; Albert Heijn, Gamma, Phillips, etc. As a source of information and a mean to benchmark HMC's procurement activities a Dutch offshore dredging company called DMCC was interviewed during this study. This company also reported to have decreased process costs considerably by setting up direct connections with multiple suppliers who are used to acquire certain parts of the procurement portfolio. The EDI interface was between DMCC and those vendors was realized via a VAN called 'Shipserve'. Prices for items which where sourced in this manner where registered in a frame agreement between DMCC and the connected vendors.

2.4.3.2 Catalogue systems

From all EP solutions, catalogue systems are found to result in the largest gains when it comes to reducing process costs. Furthermore catalogues systems are found to be especially suited for the use in procuring indirect items (De Boer et al., 2002; Harink, 2004; Van Weele, 2005). E-ordering (catalogue systems are also termed e-ordering systems), is the process wherein employees who have an operational need, can order and receive goods. In practice the goods which are ordered in this manner can be both direct as well as indirect items. This process is defined as the 'operational purchasing process by Van Weele (2005).

The back bone of e-ordering systems is the catalogue with:

- Selected products (and/or services).
- Selected vendors.
- Contract prices per product (and/or service).

In fact a catalogue system is the result of the tactical purchasing process (defining specs, vendor selection, and contracting vendors) and brings in; frame agreements, call-off contracts, etc. (Harink, 2004). To utilize the frame agreements via a catalogue system, three main types can be distinguished (Ginsburg, et al., 1999 and Harink, 2004):

- Single vendor catalogue system hosted by the vendor.
- Multi vendor catalogue systems set up by the buying firm.
- Multi vendor catalogue systems facilitated by a third party or vendor.

Specific benefits for companies in utilizing e-ordering systems have been studied by multiple researchers (e.g. Aberdeen Group 2001a, 2001b, 2001c; Davila et al., 2003; Harink, 2004; Angeles, 2007; Davila et al., 2003; Neef, 2001). The following can be considered to be the main advantages:

- Increased efficiency in the operational purchasing process, which consequently results in extra time for tactical purchasing processes.
- Shortened process cycle times. Hence, this could potentially lead to decreased inventory costs.
- Decreased direct purchasing costs due to bundling of groups of items into one contract, increased insight in purchase spend, decrease in 'maverick buying'.

As e-catalogue systems have benefits for the buying party, it has also specific advantages for vendors for using catalogue systems as identified by the Aberdeen Group (2001b):

- A 65% decrease in costs in the process of acquiring new costumers.
- 40% to 60% increase in turnover from existing customers.
- Order value increases of 2 to 3 times.
- 40% to 80% reduction in data errors.
- 20% to 30% less overhead-costs and operational process costs.

As a result from their study on the impact of e-ordering for companies the Aberdeen Group (2001a, 2001b) came up with a rule of thumb that states; that an average mid-size organization with approximately 1000 employees can realize a reduction of about $ 2 M per year. When one takes into account the costs of an average e-ordering system (including; designing, implementing, and maintenance) of approximately $ 5 M, it takes up to two year before the break-even-point will be reached (Davila et al., 2003).

Examples of e-catalogue systems which can potentially be beneficial for HMC:

- www.shipserv.com; the leading maritime e-marketplace, founded in 1999 (multi vendor, overlap).
- www.tradcom.nl; catalogue system with vendors with a complementing portfolio specialized in different industries (multi vendor, no overlap).

2.4.3.3 Internet reversed auctions

In essence, any auction is an endeavour to create a perfect market with perfect information for both buyers and sellers (McAfee and McMillan, 1987). Thus ideally everyone participating in the auctioning process has accurate knowledge about the products being auctioned as well as the particular auctioning process, and the latest biddings. Different types of auctions can be identified (Smeltzer and Carr, 2003; Beall et al., 2003): Forward auctions, 'Dutch auctions' and reversed auctions. In reversed auctions a number of suppliers and one buyer participate. In a reversed auction the prices wherefore the suppliers are willing to supply their item(s) for, drop successively in reaction on successive biddings from concurrent participants. Often the contract is not offered to the one with the lowest direct costs, but other issues are taken into account like: total costs of ownership, preferences for suppliers etc. When this type of auction is used there are many suppliers and one buyer, therefore the buyer controls the market. Since this BPSP is about a buying organization only reversed auctions will be discussed here. More specifically the focus lies on, online reverse auctions. Online reverse auctions are also termed *'internet reversed auctions' or ' e-reversed auctions'* where

the 'e' relates to the fact that they are online (e.g., Jap, 2002; Beall, et al., 2003, Harink, 2003). The abbreviation commonly used in literature for e-reversed auctions is eRA. eRA as an abbreviation for e-reversed auctions will also be used in this thesis.

eRAs just as other types of auctions can be designed in different manners. Beall, et al. (2003), Jap (2002), Chandrashekar (2007), studied what kind of different variables can be distinguished and comprise the eRA design. The different factors and their effects (based on literature and findings from interviews held at DC[4], DMCC and Quel) are:

- **Price visibility**, which refers to the visibility of quotes of participating vendors to the other participants. Visibility ranges from sealed bid to partial visible bids for all participants to full visibility for all participating vendors.
- **Closing rules**, two types of closing rules can be distinguished, but there is no evidence that one is better in certain conditions then others. In practice a combination is made between both modes. There are even examples of events where the closing rules were changed during the event, where all vendors collectively agreed upon (DMCC, DC).
- **Award rules**, are the rules which determine who will get awarded the lot which is being auctioned. A distinction can be made between rules based on the item price only and modes where other aspects, like quality of the goods, service levels, witching costs, etc. are taken into account in the ranking of bids.
- **Lotting strategy** is the way in which the total amount of items which is being auctioned is split into lots. A distinction can be made between a mode where on parts of the total contract can be quoted or only on the whole amount.

The largest potential for eRAs relate to the reduction of direct costs of the procured goods and/or services. Generally, the reported reduction in direct purchasing costs, range from 10 to 20 percent (Beall et al., 2003). Next to that, eRAs have some other benefits like (e.g. Harink, 2003; Beall et al., 2003; Marinello and Daher, 2001):

- Increased numbers of potential suppliers (which is believed to be closely related to have a decreasing effect on direct acquisition costs). Increased reach of buyers.
- Reduced procurement cycle time; this counts for both the buyer as well as for the supplier.
- Overall process efficiency; users of eRAs report that they are able to spend less time on managing the tactical and operational logistics of sourcing, enabling them to spend more time on strategic aspects such as spend analysis, opportunity assessment, market evaluation, etc. Nevertheless, these positive results possibly only set in when buyers become more experienced users.
- The opportunity to use Total Cost Analysis upfront.
- Improved market/supply chain transparency; this effect can also be beneficial for both parties.

[4] 'DC' is a fictive name for a global player in the Dredging industry.

Beall et al. (2003) and Smart and Harrison (2003) report next to benefits for buyers, gains for suppliers when eRAs are put into use. Suppliers view eRAs as a chance to retain their current business and as a possible mean to expand their business. When eRAs are used, the supplying companies can gain valuable insights into their competitive standing within their particular market environment through their own post-event analysis of the eRA outcome(s). Additional benefits to suppliers include lower marketing/sales costs, quicker award/non-award cycle times.

Although literature reports of many benefits of e-RA's, eRAs are also associated with particular risks. eRAs can be used inappropriately or when used appropriately fail to be a beneficial tool. An example of an eRA which resulted in diminishing returns was held by a global player in electrical cables called 'Power Cables'[5]. The eRA was held for the awarding of an annual contract for supplying cable reels. Before the eRA was held the price paid for the cable reels was 20 % lower than the lowest bid during the eRA. The company with the lowest price during the eRA was even the same company as 'Power Cables' sourced its cable reels from before the eRA. The result was a price increase of 20 % without clear indications of a market price increase with comparable figures (Source: *former employee of 'Power Cables'*). Other, examples of sources of disappointing results have been extensively reported in literature (Beall et al., 2003; Skjot Larsen et al., 2003; Nepelski, 2006; Reunis, 2007) examples are:

- Inadequate up-front event planning and auction rules.
- Unclear specifications.
- Difficulties in adoption at the buying organization.
- Fixing the maximum e-reversed auctioning price too low, resulting in no bidder responses for that item.
- Settling a price with a supplier at such a low price that the supplier is unable to deliver the item according to specs without the companies' survival coming into play.
- Participation of unqualified bidders.
- Suppliers collectively refuse to cooperate.
- eRAs can damage trust and mutual interdependence between the buying company and (key strategic) supplier, consequently resulting in a lowered supplier loyalty.
- Insufficient knowledge about e-auctions (buyers and suppliers).
- Increase in number of suppliers.

From all those potential drawbacks of e-reversed auctioning the influence of eRAs on supplier/buyer relationships is a topic which gained increased attention in academic literature (e.g. Barratt and Rosdahl, 2002; Beall et al., 2003; Emiliani and Stec, 2004; Smart and Harrison, 2003). Not all authors agree on the impact of eRAs. For example, Beall et al., 2003 and Emiliani and Stec, 2004 see eRAs as a tool which spurs a more transactional type of relationships, and is more applicable in situations where transactional relationships are most suitable. On the other hand Smart and Harrison (2003) found

[5] 'Power Cables' is a fictive name for a global player in the Cable industry

evidence that eRAs can be compatible in situations where relational long-term relationships are required if used appropriately.

Apart from the threats mentioned above, the suitability of eRAs for certain items is studied. Beall et al. (2003) and Emiliani and Stec (2004) both conducted an extensive study on eRAs, and identified the major attributes which e-auctionable goods or services should have:

- Items can be clearly specified (via design, terms and conditions) and translated into prices a supplier will commit to charge the buyer. It is found to be easiest for items which can be labelled as leverage and routine items. This because these items can generally be specified more easily. Furthermore the number of suppliers willing and able to bid on the item is likely to be higher, due to lower item specificity of the items. Not to say that it is impossible to eRA more complex and specialized goods or services. For complex and specialized goods preparation is even more important. In addition the proper market circumstances have to be taken into account and be present (seasonality, general economic conditions, supplier base, industry environment, buyer's reputation, demand–supply ratio) and the structure of the order (ease of fulfilling the bid package, spend of the RFQ) in order to be the eRA to be successful. Continues market research and analysis to identify appropriate eRA opportunities is needed for this purpose. If this effort cannot be extended easily in-house, specialized third-party consultants could be hired.
- There is a reasonable chance that the current price(s) charged is sufficiently higher than the market price, making the eRA event cost effective.
- Switching costs associated with changing supplier(s) is acceptable for that good or service.
- A sufficient number of qualified, competitive suppliers exist in the marketplace and those qualified suppliers of the item(s) are willing to participate in an eRA.

Furthermore, interviews where conducted with suppliers of eRA software and Dutch companies operating in the offshore business who utilize eRAs (DMCC, and DC) and a supplier of HMC (CS[6]). These interviews brought in the following additional insights regarding the use of eRAs:

- All: The direct costs for an item or contract which one would like to auction should exceed $ 100 K this due to the costs of organizing an eRA and the extra costs incurred during the preparation phase.
- DMCC, Quel, and DC: There has to be sufficient slack in the process to execute an eRA. This extra time is needed to issue proper specifications.
- DMCC and DC: Defining good specifications is most important and the largest gains can be made in this process. DC reported about an auction held for a three year cleaning contract that "documenting the specifications resulted in a

[6] 'CS' is a fictive name for one of the largest European wholesalers in: electrical equipment, hydraulics, personal protective equipment, hand tools, etc..

20 % saving in direct costs, the actual eRA in an extra 0.5-1 %". Therefore by making proper specifications the largest where made and this case the actual auction was not beneficial. On the other hand DMCC, who auctioned a three year frame agreement, reported that the actual auction resulted in a 58 % decrease in direct acquisition costs.

- DMCC: When auctioning frame agreements, auction all items instead of only the ones which make up the largest spend (80 % for instance). This to overcome discussions on other items. Furthermore an auction should only result in net prices instead of gross prices with a fixed discount since vendors can freely increase their gross prices annually (or other periods).
- All: Make sure that all vendors are well informed (on all aspects, auctioning rules, terms and conditions of the contract, etc), and all have a reasonable chance to be awarded the contract.
- All: Take into account the switching costs of yourself and the supplier.
- All: the findings of all parties suggest that eRAs can be beneficial in reducing direct purchasing costs if properly prepared.
- DMCC, DC, and Quel: When goal is to reduce direct cost prices, there have to be a minimum number of 4 vendors willing to participate in the eRA in order to make the auction effective; participants need to be triggered to lower the price, otherwise there will be no, or not enough competition between the vendors and the auction mechanism doesn't work properly.
- DMCC and Quel: Executing a sensitivity analysis and modelling outcomes if non monetary aspects are taken into account in the auction is important to gain insight in the effect of these aspects.
- DMCC: In some instances it can be necessary to pre-define a bottom price in order to protect vendors from bidding below their costs price and prevent that the vendor goes bankrupt.
- CS, DC and DMCC: Most vendors are willing to participate in an auction, but are not always happy to do business in such a manner. The most dominant complaint is that decisions to change prices have to be made in such a fast pace and short period of time.

2.4.3.4 Adoption cognition of e-procurement tools

Reunis (2007) conducted an extensive study on what factors influence the perceived ease of use and perceived usefulness and thus the adoption cognition of an EP system. Factors which influence the adoption of new technologies and more specific eRAs are explained briefly below (Reunis, 2007):

- System & Context: Characteristics of the system, the organizational processes and wider organizational context.
    - Task Technology Fit: The degree to which an organization's information system functionality and services are on the required levels.
    - System characteristics like: Functionality, equipment performance, interaction, environment, and the quality of the user interface.
- Interventions: Controllable factors that can be manipulated by an agent aimed at increasing adoption. The following categories are distinguished:

  - Social Influence (e.g. social presence, image, superior and peer influence, shared beliefs in benefits, etc.)
  - Training; for users acquire the skills for knowledge for actual usage, partly provides the prerequisite for usage, but also can serve as extended introduction.
  - Facilitating Conditions & Support. Factors in the environment that make an act easy to do and compatibility with existing values, needs, and experiences of potential adopters.
  - Roll-out strategy. This factor includes awareness, visibility, accessibility, demonstrability, compatibility, and information quality and communication channel.
- Individual characteristics of the (potential) adopter, i.e. user.
  - Age.
  - Gender.
  - Education level. Education level has been found to correlate positively with technology adoption cognition.
  - Self efficacy & anxiety. This is people's beliefs about their capabilities to produce designated levels of performance.
  - Experience & knowledge. Certain experiences can both work as predictor as well as moderator on adoption cognition.

Since, the factors described above (Systems & context, interventions, and individual characteristics) determine how easily EP tools are implemented in an organization these factors have to taken into account when implementing EP tools within organizations (Reunis, 2007).

3 Empirical analysis and diagnosis

In this section the outcomes of a study on processes taking place within HMC's procurement department are delineated on. As outlined in section 2, a TCO approach can reveal valuable insights into where the largest gains can be made for purchasing managers. Therefore TCO analysis plays a role in determining costs associated with direct and indirect purchasing in the process of acquiring products and services at HMC.

Elram (1993) concluded from his study on TCO practices within a wide variety of companies and industries that at minimum any TCO approach should include transportation costs, receiving costs, quality costs (inspection, rework, reject costs), purchasing administrative expenses, including management time, and of course, the price of the purchased item. These aspects will also be taken into account in this study. It would take too much to trace all types and precise costs for each individual item or service in this study. Therefore only the most relevant elements are taken into account, but not traced back to individual items or services and only on a global level.

First an analysis is conducted to determine which group is most promising to focus on in this study, given the current opportunities for change. Input for this analysis is gathered via semi-structured interviews with multiple key employees within each group, where special emphasis has been given to the effect procurement has/can have on TCO.

Next, the group which is most promising given the findings from the first analysis will be focused on. A more fine grained study is conducted to confirm the identified problems in the study conducted departmental wide. Furthermore, the causes, and root causes of the problem(s) will be identified to gain a more fine grained understanding of the problem(s) at hand. This information is then used to come up with a diagnosis; identifying the nature and causes of the phenomenon under study. The diagnosis will be delineated on in the hindmost section of this chapter.

3.1 Departmental analysis

3.1.1 Aspects taken into account

The elements which are taken into account in this study are those elements which at minimum should be dealt with in a TCO analysis (as suggested by Elram, 1993).These elements are delineated on below. A TCO analysis of each group will be described and accompanied with a fish-bone diagram to outline the relationship between the most dominant causes and effects which comprise the costs of acquiring and using items, and services procured via these groups.

Transportation

To start with, the transportation costs of items; purchased items need to be transported to vessels where the items are used. Since those vessels operate globally the items need to be shipped to the location where the ship operates. The location of the vessel

together with the available transportation vessels determine the most optimal shipping location (Vlissingen, Fourchon, etc.), and therefore also for a large degree the most promising vendor (location). Hence, shipping the items also impacts the lead-time of items. Transportation of items is therefore more complicated and costly when compared to transportation the same items to fixed onshore locations. Transportation in this study also includes the receiving of the goods.

Most contracts HMC signs with its clients contain penalties, and awards which have to do with the timeline in which HMC executes its tasks. Therefore it is of major importance for HMC to finish the work (well) in time. Furthermore the operational costs of HMC's vessels is very large (several K dollars). Consequently, in case one of the vessels urgently need an item or service which is a 'show' stopper the costs of delay almost always outweighs the extra costs associated with crashing the lead-time for that specific item. Hence, crashing lead-times can be accomplished by reducing transportation time, but also by decreasing production time by putting pressure on vendors, or introducing fees for reduced delivery times.

Direct purchasing

Direct purchasing costs comprise the costs which relate to the price the vendor is being paid for, for certain items. The relative (compared to optimal market prices) direct purchasing costs are determined by the degree in which HMC is able use it's leveraging power to acquire items.

A specific item which impacts HMC's (like other global operating companies) procurement costs are fluctuations in currency exchange rates. At present this especially counts for items which need to be purchased in other currencies than the dollar, since HMC is most often being paid in dollars (like most companies operating in the oil and gas industry). Hence, currently the dollar is devaluating against most other currencies and especially compared to the Euro (€).

Quality & Reputation

The author of this study follows Moffat et al. (1993) in its definition on quality (of supplies): Quality is the total of features and characteristics of a product or service that bear on its ability to satisfy a given need. Quality of products and services determine the functionality, easiness of use (speed), lifetime, and the quality of end products. As Crosby (1984) described in his book; not only quality, but potentially even more important the lack of it which costs money. Due to dimensions of the operations, and money at stake, quality is a very important factor, due to the hazards, and potential delays poor quality can bring. Therefore quality is taken into account specifically.

Quality of materials is of major importance for those items which directly or indirectly affect operations. Therefore only a selected number of suppliers are qualified to deliver these items. The quality of the vendor's supplies is mainly assured by procuring items using standard quality standards: NEN, DIN, etc. or by means of offshore quality inspections/tests by agencies like: Lloyd's etc.

Reputation is a very important issue for companies operating in the offshore. Oil companies want to mitigate risks as much as possible, mainly because of the large amounts of money involved in most projects. Only the most reliable companies with the best track records are invited for contracting projects. Furthermore even the reputation of vendors used by contractors can affect their reputation.

General remark on quality and reputation control at HMC's procurement: Although the quality of purchased items is of major importance, there is no formal measurement in place to monitor the general quality of vendors (service level, quality of deliverables, etc.). The evaluation of vendors is executed on an informal and ad hoc basis.

Administration

Administrative costs are takes into account in this analysis, which comprise all administrative and purchasing actions from the identification of the need to evaluation in the six step purchasing process as defined by Van Weele (2005) in addition; the processing of payments is also included in this analysis, since these are perceived to be large and influenced by decision made in the procurement process.

3.1.2 Floating equipment group

Project teams determine specifications for and provides request for the subcontracting group floating equipment. Therefore the purchasing group which handles all procurement activities for subcontracting floating equipment is located at the operations department. This group is the smallest with one FTE and spends $ 130 M annually.

In Figure 12 the most dominant causes for the TCO for floating equipment are depicted, the text below provides a description of the sources and the interrelation between them.

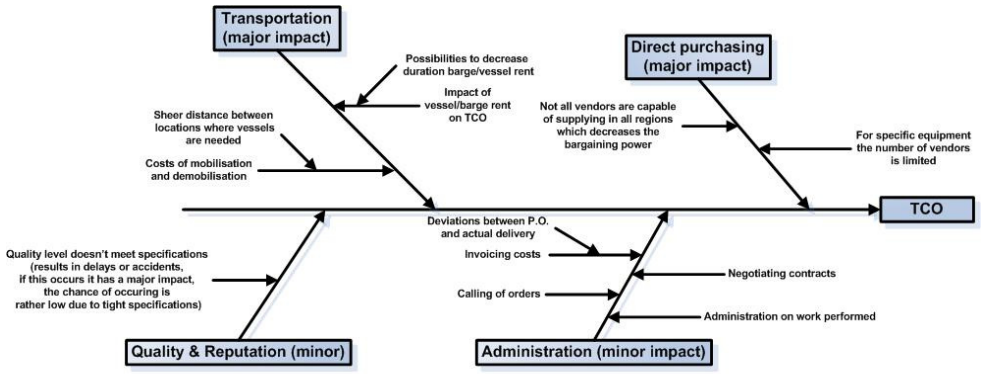

Figure 12: Floating equipment

Transportation

Mobilisation and demobilisation of vessels and floating equipment is a very expensive undertaking, this not only increases the rental period it also impacts the fuel consumption, and personnel costs. Therefore transportation makes up a large portion of the total costs of ownership for these items.

Direct purchasing costs

The number of vendors available for items can be limited since not many vendors are equipped to deliver due to capacity constraints, or specificity of the floating equipment. Furthermore, in some areas and costal waters, contractors and international oil companies are obliged to use local subcontractors (content). Another (less important) factor is the fact that not all vendors are able or willing to operate in all regions. This can be due to the location of subsidiaries/yards which are needed to keep the vessels operational, or the presence of pirates in that area.

In the current market conditions the bargaining power of buyers is most often limited; there is generally less supply compared to the demand. This situation is going to change in the near future when new barges and tugs that now are being built will be launched and become operational. In certain areas where HMC operates on a long term basis MSA's (frame agreements) are in order to leverage out temporary supply surpluses (and secure supply, reduce administrative costs). Direct purchasing costs are perceived to make up the major part of TCO.

Quality & Reputation

If the quality of floating equipment is below the contracted levels, this could impact operational speed and consequently lead to delays. Possibly the quality of floating equipment can cause accidents, and potentially harm HMC's reputation. Therefore sufficient quality is of major importance for HMC's operations and operational safety.

Although the impact of insufficient quality levels can be large, quality levels almost always exceed specs. One could argue that the quality beyond specs is redundant; this is not the case since in most cases extra capacity is hired on purpose because for instance the same vessel has sufficient capacity for sequential operations. This solution is chosen to overcome the high mobilisation and demobilisation costs are then saved between these jobs. Furthermore, specifications and maintenance levels of floating equipment can quite accurately be determined, which decreases the likelihood of hiring a vessel with insufficient quality. Therefore quality and reputation is not a big issue for this purchasing group.

Administration

Since contracts with vendors of floating equipment are not very complicated and clear (especially when compared to contracts for other equipment or services) there is not much time involved in the administrative tasks. Especially when one compares all costs for these items to the administrative costs, the administrative costs can almost be diminished.

Conclusions and recommendations

Direct acquisition costs, and transportation costs determine the largest part of TCO for Floating equipment. Transportation costs are closely monitored and decreased as much as possible. Focusing on direct purchasing costs would be therefore the most favorable focus for this group. Unfortunately due to the current market conditions the bargaining power of buyers in this area is very small. This situation is expected to

change in the near future for tug vessels since a lot of tug vessels are being built. When those vessels become operational, the power balance will shift to the buyers. eRAs could be a mean to take full advantage of this situation.

During most operations of the crane vessels, tug vessels and barges are needed for assistance. For this purpose HMC owns two tugs, and a number of barges, when needed HMC hires additional ones. When one analyzes historic data on tug rental, most periods there are minimally two additional tugs are hired. For this purpose two long term agreements are in place for those tugs. Depending on market circumstances hiring can be economically more attractive compared to hiring them. Currently, the hire or buy decisions are being made at a top management level. The author of this thesis recommends installing a hire or buying analysis tool on a sectional or group level in order to supply top management with information to base their "hire or buy" decision on. Since the floating equipment group has more thorough information on market conditions and future projects, valuable analyses can more easily being made here. Hence, installing such a tool will most likely also increases the strategic position of this group, section and the procurement department as a whole.

3.1.3 Vessel purchasing group

Spend for the group which is responsible for the vessel generated purchases amour 45 M. The number of FTE involved in vessel purchasing counts up to 5 FTE. Hence, when the new build vessel is ready for use, the workload will increase by 1/3 (from 3 crane vessels to 4). PR's are generated on the vessels, when the appropriate budget holders have approved the request(s), the PR will be send to either the Leiden office or the US office. At the offices the PR will be processed. After the appropriate persons have approved the PR, RFQ's are then send to the vendors via fax (this process is automated within the current ERP software system). After the tendering process has resulted in a vendor who can deliver under the best conditions this vendor will be awarded a PO contract. The European vendors almost always deliver their goods at HMC's port and warehouse in Vlissingen, US vendors do the same in Fourchon. Depending on the location of the vessels the goods will be delivered directly from one of the ports to the vessels or first transported to a nearer port. When the supplies arrive at one of the warehouses or on the vessel (in case it is directly delivered to the vessel), this will be registered in the ERP system, which results in a signal for accounting to pay the accompanying invoice(s). The global information flow is depicted in Figure 13.

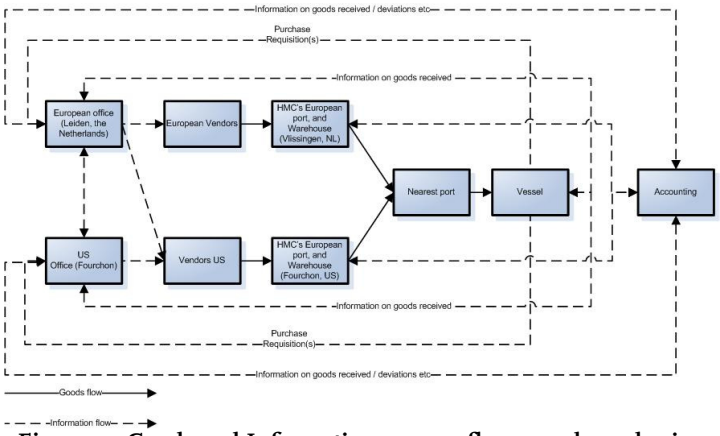

Figure 13: Goods and Information process flow vessel purchasing

In Figure 14 the most dominant elements of the TCO for vessel generated purchases are depicted, the text below provides a description of the sources and interrelation between them.

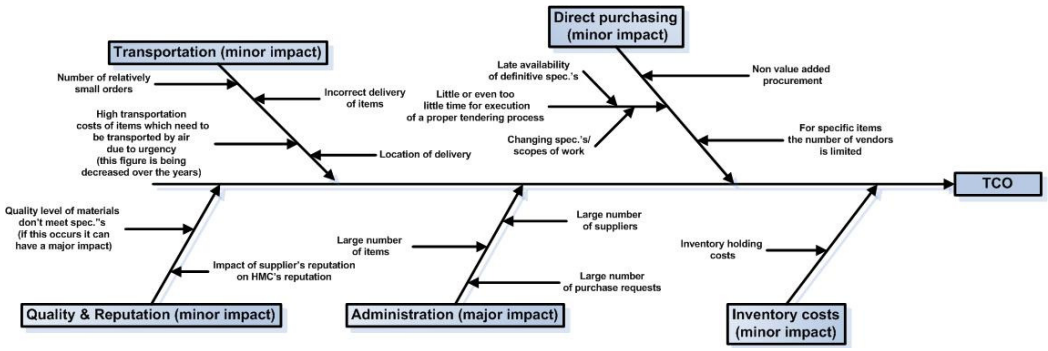

Figure 14: Vessel purchasing

Transportation

Each vessel identifies its own need which is then procured centrally at HMC's head office in the Netherlands or US. Furthermore the need for each vessel is identified individually, and the purchases of each vessel are delivered separately (to overcome problems with sending parcels to individual vessels). For relatively small (size and price) parcels, the costs of transportation which is directly or indirectly being paid for the parcels can proportionally be large.

Another important source of the total amount of transportation costs can be assigned to those items which need to be transported via air to crash the lead-time. Most often this is due to late identification of the need, or specific conditions which give rise to the need for certain items where the need for those items cannot be anticipated on.

A minor impact has the incorrect delivery of parcels. Depending on the location of the vessels, and transportation vessels the delivery address changes. Due to these changes, and the large number of vendors, parcels sometimes get delivered at an incorrect address, which introduces additional costs.

When one compares the average value of the products to the costs of transportation one state that transportation costs compared to all other costs of the product are low.

Direct purchasing costs

Most items bought within this group can described as consumables or MRO items. This means that a large variety and number of items are procured, and the average value of those items can be considered low compared to other items which are procured by the department.

Due to the specificity of a large part of the items, there are not many suppliers who can deliver/produce the goods which negatively impacts the bargaining power of HMC, and impacts the number of suppliers HMC needs to conducts business with.

Another issue which impacts the direct purchasing costs is maverick buying or as it internally is called "*non value added procurement*"; procurement of items where employees purchase items and do not make use of company or corporate agreements, and use a acquisition process that do not meet the company's purchasing policy (van Weele, 2005). This potentially leads to prices which could be lower in the case if the proper procedures are followed or the right frame agreements were used. Within HMC, maverick buying most often occurs when one of the departments wants to crash the lead-time. Currently a program has been set up to minimize the amount of maverick buying.

Quality & Reputation

Most items vessel purchasing procures are MRO items, food, and personal protection equipment; these items have most often no direct impact on HMC's operations. The quality of items for vessel purchasing has most often to do with life-time (MRO items), easiness of use (tools), comfort (safety equipment, boots), personnel's preferences (food) etc. Therefore quality can be of issue for certain items, but differs considerably per item.

Administration

For vessel purchasing counts that, due to the low value, considerable amount of PO's, and line items the administrative costs associated with the purchasing and payment process are considerable compared to the direct acquisition costs for those items. Therefore administrative costs have a major impact on the total costs. This especially counts for low value items, and less for the more expensive ones. The costs of processing a PR until goods are delivered and the invoice has been paid is perceived to exceed $ 200,-

The costs associated with processing PO's are especially high when one takes into account the large number of PO's with a very low value (up to $ 1.000,-). The total number of POs, associated PO values, and number of vendors for all purchasing activities within HMC are depicted in Table 18 (in Appendix III: HMC's Procurement data). Hence, from all processed PO's with a value below $ 500, - 90% is perceived to

be processed by the vessel purchasing department). Note that for those PO's with a value under $ 1.000, - the processing costs of a PO makes up a very large portion of the total TCO for those items.

Inventory holding costs

For the vessel generated purchases the largest inventory is held on the vessels. Hence, the variety in work which is performed by HMC directly impacts the variety of items on stock on each vessel. It is the storekeeper's task to balance the stock in such a way that the vessel doesn't run out of inventory for certain items, and inventory holding costs are still acceptable.

When one only takes into account the spilled interest rates on inventory and warehouse costs, this is perceived to have not much impact on the total costs per item.

Conclusions and recommendations

One of the most dominant sources of TCO for vessel purchasing are the administrative processes associated with purchasing for the cheaper items, and direct purchasing costs for the more expensive items. For a large number of items the processing costs ($ 200,-) make up a very large portion of TCO. Hence, for some of them those costs are even larger than the direct purchasing costs. Due to the large number of items (> 300.000), line items (> 20.000), and PO's (> 5.000) annually purchased by the vessel purchasing department, decreasing processing costs can have a large impact. More innovative instruments for purchasing these items can potentially lead to a decrease in direct purchasing costs, and administrative costs. Instruments where one can think of are EP tools, automation of process steps by the introduction of IT systems, and a redesign of process steps.

This means that it could be very beneficial for those low value PO's to implement means to decrease administrative costs. Means where one could think of are; reducing the number of low value PO's, automating processes, reducing the number of steps in the process, etc.

Other important factors which impact the direct purchasing costs are:

- Currently there is no clear differentiation in purchase strategy, presently, a bottleneck sourcing approach is utilized, and similar processes are used for all items. Differentiating in sourcing strategy (e.g. bundling, automation of processes) can be fruitful when considering findings from literature and company visits. Especially bundling of groups of items in frame agreements can reduce direct purchasing costs as well as process costs (DMCC).
- A limited number of suppliers receive the vast majority of spend and PO's. Where the supplier base has grown historically. Sourcing from alternative vendors can decrease especially direct purchasing costs.
- Most often requisitions are based on item nr of suppliers instead of technical specifications, which makes changing supplier a difficult undertaking and thus impact direct costs prices in a negative manner.

3.1.4 Non vessel purchasing group

The spend for the group non vessel purchasing adds u[redacted]'5, - M. The number of FTE involved in non vessel generated counts up to 3 FTE. PR's for technical equipment originate from the Equipment Management (EM) department for projects related to maintenance of the vessels, or related to projects from the project department.

Contracts with employment agencies are also awarded via, and negotiated by the non vessel purchasing group. Requests for these orders originate at the human resource department. The number of FTE involved in executing this work is 0,5 FTE.

Fuel is also procured via non vessel purchasing which makes up a large amount of total spend, namely [redacted]. Next to fuel, large items which have to be purchased as a supply for one of the offices, office and house rental is also accommodated by this group.

An image of the outcomes of the TCO analysis conducted within this division is depicted in Figure 15.

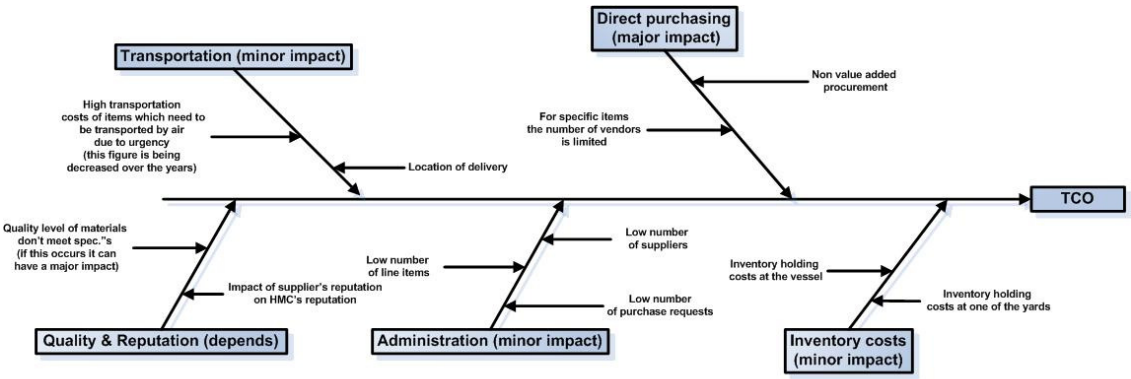

Figure 15: Non vessel purchasing group

Transportation

Two important sources impact the height of the transportation costs, and that are the location of delivery, and the transportation mode: by air, truck, or vessel. Generally due to the relatively high value of the items the impact of transportation costs is low. For fuel only 0.56 % of the TCO is determined by transportation costs (source internal). Exceptions are hard to move objects, like large cable reels. Therefore it heavily depends on the type of item what impact transportation has on TCO.

Direct purchasing costs

Most items are rather specific or are ordered in large quantities, this makes that not many vendors are able to deliver. This results in low bargaining power for HMC for certain items. Considering the average price one can conclude that the direct acquisition costs is one of the most dominant cost drivers. Hence, for fuel the direct purchase costs are determined for 96.43 % (source internal) by the direct acquisition costs. For crane and anchor wires also the largest portion of TCO is made up by the direct purchasing costs.

Items where the largest costs are not determined by direct acquisition costs only are: items purchases for general purposes (coffee machines, stairway handles, etc.), small project related items (small slings, shackles)

As within the vessel purchasing group, maverick buying occurs. Currently a program is initiated to decrease non value added procurement for these purchases as well.

Quality & Reputation

For the non vessel generated items the quality of purchased items has a more direct impact on HMC's operations, this is the most important issue for procuring these items. For most of these items the life-time of the products is also an important issue, especially for the larger and more valuable items (crane wires, large hosting equipment). This is an important issue which is taken into consideration when procuring those items. Another portion of all products procured by this group, are only used for a single project and than scraped or small hoisting equipment, fuel, and oil. For those items the life-time is not an issue.

Administration

Costs which are associated with the purchasing process per requisition are relatively higher compared to those of the vessel purchasing. This is mainly due to the fact that requisitions are less clear-cut, compared to requisitions processes at vessel purchasing. But, compared to the price of the procured items, administration costs can be diminished.

Inventory holding costs

Items purchased by non vessel purchasing can be acquired for the purpose of a project only, or not. Project items are shipped to the vessel, and then used during a project. After finishing the project some items are scrapped, others are shipped to one of HMC's yards and stored there (and potentially reused). Items which are not used for a single project have not a predefined route etc. therefore it heavily depends on the type of item what impact inventory holding costs have on TCO. In general inventory holding costs are perceived to impact little on TCO costs.

Conclusions and recommendations

Direct purchasing costs determine the largest portion of the TCO costs. As discussed in this analysis many items purchased by this group can be categorized as strategic products (high supply risk, high impact on financial results), and a small portion as leverage items.

In general partner programs would be a logical step for strategic items to secure supply and guarantee quality. For the leverage items, exploiting buying power is most profitable; eRAs could be used to reduce purchasing costs for those items. The impact of introducing eRAs could be beneficial depending on the amount and expected reduction of spend for leverage items which are suited to be sourced via eRAs. Hence, when implementing e-reversed auctioning the impact of eRAs on buyer-supplier relationships need to be taken into consideration.

3.1.5 Subcontracting equipment and services group

Currently, 13 FTE work in the group subcontracting equipment and services, and spend [redacted] annually. Per year, approximately 800 contracts are signed with subcontracts for hiring equipment or for the execution of services. The need for a certain service is identified by project teams or the equipment management department. The section head of the subcontracting section allocates the requests to the most suitable subcontract coordinator who further processes the request(s).

The cost structure for items which are subcontracted is depicted in Figure 16, the text accompanying supplies the reader with additional information.

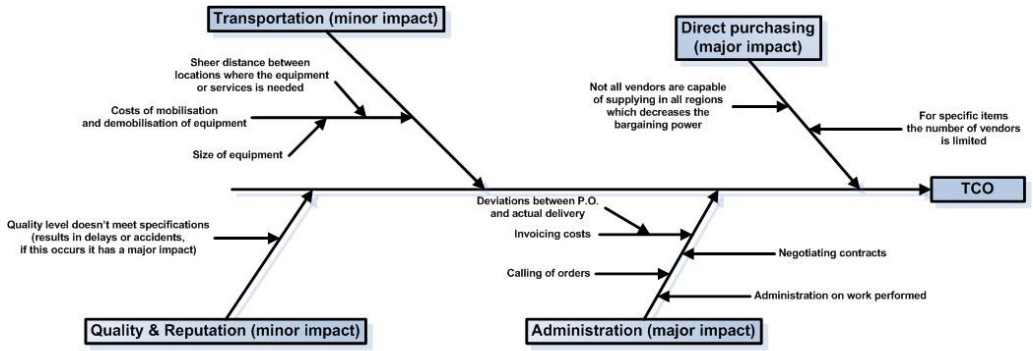

Figure 16: Subcontracting

Transportation

An important aspect of the transportation costs of equipment and services are the offshore mobilisation and demobilisation costs. This is especially the case for large equipment and/or services where large equipment is used, and the time span in which the equipment is used is short. Especially in those cases the transportation costs determine for a large part the total subcontract value for those items or services. Consequently the subcontracting department has not much influence on costs associated with transportation; this for the largest part depends on planning of projects.

Direct purchasing costs

Most subcontracts have a value above $ 20 K and range up to multi million dollar contracts. When compared to indirect costs the costs associated with direct acquisition costs, this is the most dominant factor for most agreements.

Generally the number of vendors available for items is limited since not many vendors are equipped to deliver. This makes that for some items the bargaining power of HMC is limited. Hence due to the current market conditions determine make that some resources are scarce. Another less important factor is the fact that not all vendors are able or willing to operate in all regions.

In situations where only one (or 2) party dominates a certain market (has a monopoly position in a certain area) HMC initiates supplier development projects, this in order to

spur market competition. Currently no formal management system is in place to steer the development of vendors. The development of vendors occurs on an ad hoc basis when procurement, and HMC's management board thinks this is appropriate. These long term relations can be a mean to increase competition. On the other hand long term relations can result in "lazy suppliers" who don't feel the urge to prove themselves since "they are already working on a vessel". Therefore HMC's strategy is to contract at least two contractors who each work on a given ship for a longer time period. This enables HMC to gauge the quality levels of both suppliers and benchmark both suppliers against each other in order to ramp up quality levels.

Quality & Reputation

The subcontracted equipment and services are almost always used in critical operations. This implicates that the quality of subcontracted equipment and services directly impacts the quality of the end product, speed of operating, and the safety level of operations. Thus the quality level of subcontracted equipment and services is of major importance and impacts TCO. Therefore contracts with subcontractors deal with those issues extensively.

Quality and reputation issues are also the reason that basically only vendors are used which have a good track record in certain areas. In special cases new vendors are introduced in a certain area, by means of a vendor development program in order to set a new standard when it comes to quality or improve HMC's bargaining power.

Administration

In general procuring services is a much more complex endeavor with a much more complex process and different associated risks when compared to sourcing goods or equipment (e.g. Fitzsimmons et al., 1998; Smeltzer and Ogden, 2002). This is mainly caused by the characteristics of services which are less tangible which makes evaluating the vendor much more complex, especially in combination with the many dimensions which service quality include: reliability, responsiveness, assurance, empathy, and tangibles (Parasuraman et al,. 1985). Therefore specifications of services can be described less accurate and inspection of incoming goods can be executed less precise. Therefore the process of contracting vendors for equipment and services is a time consuming task.

Negotiating the proper terms, and conditions for subcontracts is a time consuming process. To reduce the costs associated with negotiating contracts, MSA's are used for those services and equipment that have to be contracted on a regular basis. Furthermore MSA's are also a mean to get a better grip on the costs of future projects, and can be used as a tool for planning purposes.

When a contract is in place and the vendor executes its services or rents its equipment the amount of work, hours, used materials, etc has to be monitored. Due to inevitable variations between the actual work performed and the initial contract, this is very important. These deviations also impact the processing of invoices, since the accounting department also has to take all these deviations into account when processing invoices.

Due to the amount of work associated with each contract, administration costs have a large impact on TCO for subcontracting. This is especially the case for low value and critical operations.

Conclusions and recommendations

The process to acquire the proper equipment, payment of services, and direct acquisition cost take up the largest portion of the TCO for most equipment and services. The acquiring and payment process for services and special equipment is a delicate and time consuming task which is inherent to those kinds of services. MSA's are a mean to decrease negotiation processes with vendors, services, and equipment which are used on a regular basis. Furthermore MSA's can improve quality levels, secure supply and can be of value for planning purposes. Currently no consensus exists within HMC on what a MSA really comprises of: Service Level Agreement (SLA), rate contract, frame agreement, scope of work definition, or any combination of these. Due to this inconsistency and vagueness around the term MSA's it is difficult to know what it really comprise of. Properly defining and venting what a MSA is, and what kind of different types can be distinguished can be of help in determining the appropriateness of using the different kinds of MSA's and monitoring whether a MSA is potentially beneficial or not.

A program to get MSA's in place when appropriate has started a few years ago, to reduce the administrative burden associated with it. Currently the target has been set for getting 55 MSA's in place. The figure of 55 MSA's has been determined arbitrarily; the effect of MSA's on costs has not been analyzed till now, when this is done a figure which is potentially more optimal for HMC will be found, and the target of 55 MSA's can be adjusted.

As stated in the analysis, quality of equipment and services is an important issue. To improve quality of equipment and services supplier development programs are used to achieve this goal. This mean is also used to introduce new vendors in order to improve HMC's bargaining power (decrease monopolistic / oligopolistic supplier markets/behavior
), and reduce supply risks.

As can be derived from the analysis the subcontracting equipment and services group is developed quite extensively. Potential directions for change could be to further extend the MSA, and supplier development program. Furthermore, implementation of a tool for analyzing "hire or buy" decisions could also be of value for this group, and potentially increases the strategic importance of it.

3.1.6 Subcontracting fabrication group

Presently there are 3 FTE directly involved in contracting fabrication items. Requests for acquiring fabricated items come from HMC's engineering department. The subcontracting section then awards contracts to the most favourable contractor who can fabricate these items. The items are then transported to the vessels or are directly mounted/placed on a vessel.

Annually a total of [redacted]n fabrication contracts are awarded. The cost structure of fabrication is depicted in Figure 17 and discussed below.

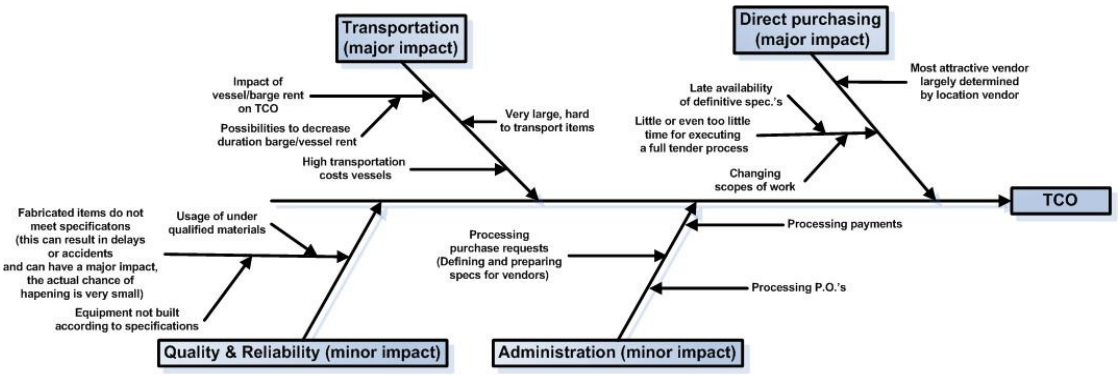

Figure 17: Cost structure fabrication

Transportation

Both the transportation of the fabricated items and more dominantly transporting the vessels on which the fabricated items need to be installed are very costly. Therefore the location of the vessels for a large degree determines the location of the most economic vendor.

Due to the high day rates of the (crane) vessels, and barges, there is continually sought after ways to decrease rental periods. Furthermore changes in project order can lead to changes in equipment which will be used for certain jobs, and consequently changes in vessel on which the fabricated items need to be placed, or the location where this has to be executed. This implicates that changes have to be made in the design of the fabricated items, and/or the location where the items need to be placed on a vessel, while the job has already been awarded. Although the subcontracting department has to incur extra direct purchasing costs due to these changes, they can more importantly reduce rental periods by swiftly change vendors, or adjusting orders against large extra costs. Due to the major impact transportation has in the total costs; this factor is labelled as a dominant factor.

Direct purchasing costs

As stated under the heading transportation, the most attractive supplier is largely determined by the location of the vendor in combination with the location of the vessel on which the items need to be placed (or further machined). This also impacts the possibilities to execute a tendering process. Furthermore, the supplier base currently utilized is quite limited, and the majority of spend, and PO's are awarded to a small number of vendors.

Due to weather conditions or delays in delivery of goods, HMC project planning can change. This group also has to deal with changing specifications as a result of changes in available barges for instance. All these circumstances put pressure on (the time available for the) procurement processes. The increases in time pressure on lead times

and thus the tendering processes, amplify the power on the supply side. Furthermore, due to the current market circumstances vendors have not much spare capacity, which increases average market prices. The time pressure impacts the tendering process and the number of qualified suppliers available, which originates form the late availability of definitive specifications and changing scopes of work.

In Table 19 Appendix III: HMC's Procurement data one can find the annual figures of fabricated technical equipment for HMC for the years 2005, 2006, and 2007. As can be deducted from these figures there are many repetitive vendors. Developing new vendors to increase bargaining power/decrease oligopolistic supplier behaviour can be beneficial.

The direct purchasing costs for purchasing fabrication items are next to transportation costs the most important factors which determine TCO.

Quality & Reputation

Issues around quality and reputation can originate when the supplier uses under qualified materials and or the inappropriate specs are used. Due to safety factors quality and reputation issues have never, and most likely will not arise.

Administration

When one takes the specification phase for fabrication into account one could argue whether the engineering for these items should be added to the costs of specifying items. In this analysis it is not, otherwise these costs will be most dominant. Due to the low number of purchases and clear well specified contract documents (technical drawings, norms, etc.) between supplier and buyer processing PR's, payments, etc. does not have much impact on total costs for these items.

Conclusions

The direct purchasing costs and transportation costs determine the largest portion of TCO for these items. Since, only a small number of vendors is currently sourced from, seeking for new qualified suppliers is also a potential avenue for improving bargaining power. The same counts for developing new vendors, since this potentially will result in new suppliers and thus increased flexibility, bargaining power, quality, etc.

A potential direction for change could be to introduce eRAs as a mean to decrease the time spent on negotiating prices. Hence, this solution is only promising in the case there are enough qualified suppliers in the area where the fabricated items are needed, vendors are willing to participate in such an event, and the relationship between buyer and supplier is expected not to be harmed severely.

3.1.7 Conclusions from the departmental analysis

As initially presumed, the above described analysis reveals that each group has its own specific procurement methods and dominant cost drivers when it comes to TCO for the items each group procures. Table 5 shows the most dominant cost drivers per

group as has been found in the above described analysis. It reveals that the most important cost driver in all groups is the direct costs of acquiring them.

Cost drivers / Divisions	Spend (in $ Mln)	Transportation	Direct purchasing costs	Quality and reputation	Administration	Inventory holding costs
Floating equipment		+	++	-+	-	N.A.
Vessel purchasing		-+	-	-	++	-
Non vessel purchasing		-	++	-	-	-
Subcontracting equipment, services		-	++	++	+	N.A.
Subcontracting fabrication		+	+	-+	-	N.A.

Legenda:
+ Much impact
++ Very much impact
- Little impact
-- Very little impact
-+ No or very little impact
N.A. Not Applicable for this division

Table 5: Overview of dominant cost drivers per section

When one relates the findings to the purchasing development model by Van Weele and Rozemeijer (1998), the groups subcontracting and floating equipment can be placed in stage III of the procurement development process model (See, Figure 18). Since, the vessel purchasing, non vessel purchasing and fabrication group's position is somewhere between stage I and II.

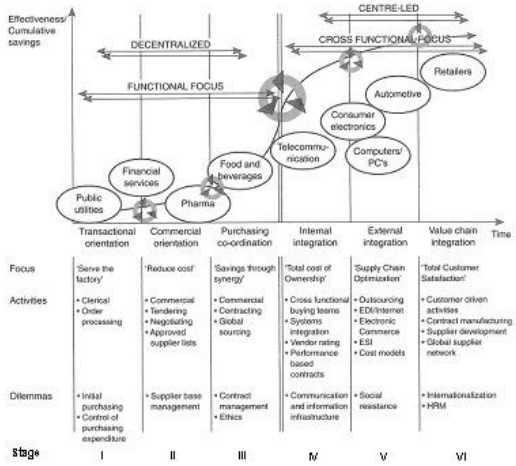

Figure 18: Purchasing development model (Van Weele and Rozemeijer, 1998)

The subcontracting section is developed quite extensively and plans are in place to further advance procedures, and working methods. Considering the findings this group currently operates in stage III and IV of the development model (See, Figure 18). Therefore it is most likely that this will not be the most promising group to focus on for implementing more innovative means of procuring.

From the analysis can be concluded that optimizing the vessel purchasing group's processes would be a rewarding avenue for this study due to the high costs associated with the process (due to the large number of line items, PO's, vendors, etc.) and

possibilities to decrease these costs (automation, change processes, etc.). The development stage (See, Figure 18) wherein the vessel purchasing group currently operates in, is somewhere between stage I and II. When one follows the suggestions of Van Weele and Rozemeijer (1998) one can state that there is much room for improvements. Furthermore this department's workload will increase in the near future when the new built vessel becomes operational.

Another rewarding direction for this study would be to find ways to further decrease direct purchasing costs within all groups. This doesn't mean that HMC currently pays prices which are far too high, but when other procurement strategies are utilized prices can be reduced. Furthermore considering the high average value of the items procured within the whole department, spend of the department in general, and the fact that the most dominant cost driver is direct acquisition costs this is can be considered as a valuable direction to focus on.

Together with the company supervisor and principal the decision has been made to focus on the vessel purchasing group. This decision has been made as a result of this initial study in combination with taking into account the company's and personal interests. The objectives of this focus are decreasing TCO by focusing on process costs, and direct purchase costs. Furthermore extra time available for buyers to focus on tactical purchasing for the vessel purchasing group is also perceived to be beneficial (more focus on: supplier assessment, supplier selection, annual or long term (frame) agreements, etc.).

This leads to the following focus of this design study: *Design solutions to improve purchasing processes within HMC's vessel purchasing department, and find means to decrease direct purchasing costs in the other groups. Furthermore provide a change plan to implement this strategy.*

3.2 Focussed study: Vessel purchasing group

As discussed earlier, administrative costs - all administrative and purchasing actions from the identification of the need to evaluation in the six step purchasing process as defined by Van Weele (2005) in addition, the processing of payments is also included - are very dominant costs for the purchases at the vessel purchasing group considering the TCO for these items. A detailed exploration is conducted to confirm if this is the case and to identify the symptoms, symptomatic causes, and root causes.

This exploration starts with analysing in detail, the internal (HMC) processes used to process PR's, PO's, and invoices. Time and thus costs associated with executing these processes will be calculated. Extra attention will be given to explore the dominant sources which impact the above stated process. Data for this analysis will be gathered by interviewing personnel who execute these processes.

In a sequential stage a fine grained analysis will be conducted on the purchased goods and supplier portfolio within HMC's vessel purchasing group. Main objective is to find what impact certain suppliers have on the purchasing processes. Furthermore, insight is gained in the type of products bought and (the number of) suppliers used to acquire

these items, and whether differentiating strategies for certain vendors, products and/or product groups could be an awarding purchase strategy. Information for this analysis is mainly gathered via archival records (data sources, like SAP (HMC's ERP system), and MEM (HMC's Maintenance, Equipment, Material Management system)).

3.2.1 Internal purchasing processes

The procurement process model by Van Weele (2005) as introduced earlier (in section 2.1 Procurement and procurement proces) will be used to model the procurement process of the vessel purchasing group, and to further analyze the processes, and costs associated with the process of fulfilling the need of internal customers.

Since payment of invoices is considered to take up a large portion of costs in the procurement processing, and is perceived to impact/is impacted by the procurement process, payment is added to the model of Van Weele (2005). The adjusted model of Van Weele (2005), including payment, together with a concise description of the processes is depicted below (Figure 19).

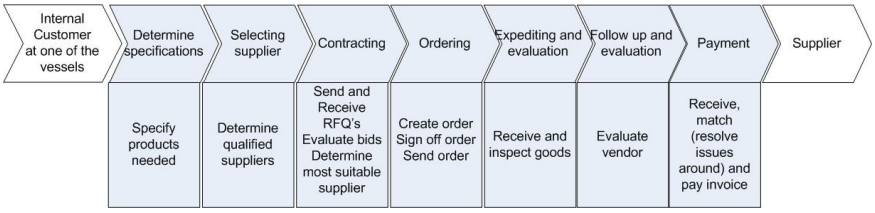

Figure 19: Procurement process model at HMC's vessel purchasing group (Adapted from: Van Weele, 2005)

To provide the reader with a better understanding of the purchasing process at vessel purchasing group, the process is described below and depicted in Figure 27 in Appendix V: Vessel purchasing . In this figure the process has been split according to the seven steps as depicted in Figure 19.

As stated earlier the internal purchasing process within the group vessel purchasing starts with the identification of the need on board of the vessels. The persons authorized of doing this are the (chief) storekeeper, and technicians. A purchase requisition has to be made to get these items acquired. On this requisition the specific items need to be specified (selected from the database which comprise over 30.000 items), this is done via a so called MEM system by 'Oracle'. Currently each vessel has built and manages its own material master; this means that each vessel labels stock keeping units and all procured items in their own manner. This implicates that between those vessels data about purchase history, prices, usage, etc. is difficult (not to say impossible) to compare or evaluate. Currently HMC is running a program to replace the MEM system built by 'Oracle" with a MEM system built by 'Infor'. This system from 'Infor' will use a central database which is managed centrally. All materials, equipment, etc. will be assigned a unique code and labels which will be used by all vessels and items with multiple item names and codes will be history. Easier analysis of data will be enabled by this system and new working method. This also

impacts the opportunities to manage categories, and analyse which vendors are used for certain items, price changes, etc.

When the purchase requisition has been finalized, the purchase requisition needs to be approved by the budget holder on the vessel and if applicable also by a responsible budget holder onshore, before it is sent to the procurement department.

Next, when the requisition has been approved, the secretaries will print and distribute these to the buyers. The buyers will further distribute the requisitions to the most applicable procurement officer. Most often the requisitions are split according to the vessels (each vessel has a dedicated buyer, which is especially useful for interactions between vessel and office). Then a RFQ and a selection of vendors will be made in SAP. The RFQ will subsequently be sent via an automated fax system to the selected suppliers.

Suppliers will receive the request for quotation and then decide to send a quotation or not. Most often quotations from suppliers are sent by fax to HMC. The faxed quotations are collected by the procurement officer who then evaluates the bids and decides which the most promising vendor is. When the decision has been made which vendor can deliver under the best conditions, a PO is created signed off by the procurement officer, sent to the vendor by the secretary (only foreign vendors will receive also receive a confirmation by fax).

The vendor will receive the order confirmation via mail, process it, send the items and invoice to the appropriate locations. Logistics receives, and if necessary inspects, the goods, ships the items to one of the vessels and registers the goods as received. When the goods are received on the vessel the goods will be inspected (almost always).

Accounting comes into play when the vendor has sent the invoice belonging to the PO. This department checks whether the goods are registered as received and check whether the order, goods received, and invoice match. If this is not the case the responsible persons are informed and the issues will be dealt with. As a final step in the process the procurement officers evaluate the vendor (there is no formal process in place for doing this, most often this occurs ad hoc).

In addition to the process described above, there is a parallel process for requisitions originating from OPS, EM department, etc. This process is similar to the process as described above, except that the stage; “determining specifications” is executed by an employee (of one of the departments) at the Leiden office. Since this process is executed by a large number of employees and departments, it is difficult to model this process and to get a grip on costs associated with the process before a PR is sent to the purchasing department. The sequential steps (from determination of specification on) in the process are similar for the requisitions which do not originate from the vessel. Hence, the succeeding process steps therefore can be treated in parallel with the vessel generated requisitions.

3.2.2 Costs per process step

In order to explore what costs are associated with processing PR's employees involved in this process are consulted. As can be derived from Figure 27 in Appendix V: Vessel purchasing not every person involved in the process is involved in each process step, therefore these persons do not impact the costs associated with these process steps (in case the process doesn't deviate from the regular process).

Table 20 (in Appendix V: Vessel purchasing) shows the positions which are consulted for the purpose of extracting the costs associated with the purchasing process and additional information on what factors impact on these processes.

Data from the interviews and questionnaires are used to calculate the average costs of processing a PR per process step. Equation 2 has been used for this purpose.
In Equation 2 the weekly number of hours per job function is multiplied by 52 to arrive at the number of hours annually spend per job function, multiplying this figure with the annual gross wages per function and divide this figure by the number of hours worked in this business function gives the total annual costs for processing all PR's. This figure then can be divided by the number of PR's in order to arrive at the costs per associated PR/order.

$$C = \frac{\sum \left(\frac{(h*52)*y}{H}\right)}{N}$$

$C = Costs\ per\ P.O.$

$h = average\ weekly\ amount\ of\ hours\ spend\ per\ job\ function$

$on\ purchase\ vessel\ generated\ purchase\ orders$

$H = yearly\ number\ of\ hours\ spend\ within\ a\ certain\ job\ function$

$y = yearly\ \exp enses\ for\ a\ specific\ job\ function$

$N = Number\ of\ P.O.'s$

Equation 2: Process costs

An overview of the time which spent per job function can be found in Table 21 and Table 22 (in Appendix V: Vessel purchasing). It shows that the total costs associated with processing a PR amounts up to: $ 259, -. This is (even) higher than the perceived costs of this process. And considerably higher than the costs of processing an internal order for indirect spend as identified in a study by Accenture (2007) which was found to be $ 97, - in 2007 (Accenture, 2007).

Determine specifications	Supplier selection	Contracting	Ordering	Expediting and evaluation	Follow up and evaluation	Payment	Total
$64	$39	$47	$12	$67	$13	$18	$259
25%	15%	18%	5%	26%	5%	7%	100%

Table 6: Process costs per process step in the procurement process

The interviewed persons stated that the time associated with processing a PR (RFQ, order, etc.) is almost independent of the value of that PR (RFQ, order, etc.). This is in line with earlier findings by Palmer (2000) who reports about a study where over 100 companies where involved that for small purchase ($100 or less) or a large purchase

(over $10,000), the same overhead costs have to be incurred (on average $ 91). For low value purchases, this means relatively high overall purchasing cost. However, the interviewees revealed a number of issues which cause the process to delay or take more time than usual. These issues and their causes are described in Table 23 in Appendix V: Vessel purchasing .

3.2.3 Purchase portfolio analysis

To obtain a better understanding of what is procured by the vessel purchasing group this specific portfolio is analyzed. Goal is to be able to judge if the current process, and associated process costs are appropriate.

The inputs used for this portfolio analysis are the PO's of 2007, executed by the vessel purchasing group. PO's from this group contain most often items like: food, maintenance and repair items, cutting tools, hand and portable power tools, safety supplies, welding supplies, medical supplies, electrical, electricity, fasteners, bolts and nuts, relatively small) slings, (relatively small) shackles, and steel profiles. The total value annual spend within this group is $ 24 Million dollar. PR's for these items are almost all initiated on the vessels. The need for these items is almost impossible to predict and random. Key figures of these purchases are presented in Table 7 below.

Vessel purchases

Range from	$ -	$ 500	$ 1.000	$ 10.000	$ 100.000	ALL
Range to	$ 500	$ 1.000	$ 10.000	$ 100.000	$ 10.000.000	ALL
# order lines (line value)						
% of total order lines						
Total value (within order line value range)						
Average order line value						
% of total value						
# P.O.'s						
% of total P.O.'s						
Total value (within P.O. value range)						
Average order line value						
% of total value						

Table 7: Key figures vessel purchasing group

As can be derived from the figures in Table 7, a considerable amount of PO's are processed with a low value (below $ 500, - and between $ 500, - and $ 1.000,-). For those purchases the process costs associated with HMC's purchasing process has a large impact on TCO for these products (for those goods the process costs increase TCO by respectively >50 % and >25 %).

The portfolio analysis of the purchases at the vessel generated department will be conducted according to the suggested approach by Kraljic (1983) and Van Weele (2005). See also chapter 2 for a theoretical evaluation of these methods. Kraljic (1983) and Van Weele (2005) suggest analyzing the purchase portfolio by comparing the volume of purchases or percentage of total purchase costs in relation to the criticality of these purchases on the company's operations. In order to execute the analysis of supply risks associated with each group properly a suitable and functional description of supply risk has to be used. For this purpose supply risk has been operationalized as and considered to comprise risks like catastrophes, financial risk, key person risk, labor risk, currency and political risks, and many others (As suggested by Berger et al., 2004). Furthermore the number of available vendors for certain goods is taken into

account since supply risks are usually expected to highly correlate with the number of alternative suppliers available (Gelderman and Van Weele, 2003) therefore the number of available suppliers for a certain group of purchases is also taken into account. The supply risk has been determined by consulting the procurement officers which rated the groups on its supply risks.

In Figure 20 the different groups of spend are depicted on a matrix with on the x bar the supply risk, and on the y bar the profit impact. The profit impact has been operationilzed as; "the strategic importance of purchasing in terms of the percentage of raw materials in total costs and their impact on profitability".

The profit impact has been determined as the relative size of PO against that of the average PO value of the whole group (See Equation 3). The size of the balloons in Figure 20 depict the total spend within each group in 2007.

$$A = \frac{x}{\frac{1}{n}\sum_{i=1}^{n} x_i}$$

$$x = Average\ P.O.value\ within\ a\ certain\ group$$

$$n = Number\ of\ divisions$$

Equation 3: Relative PO size

As suggested by Gelderman and Van Weele (2003) a portfolio analysis with a Kraljic matrix is a good starting point of portfolio analysis, but definitely not the final finishing point. In-depth discussions on the positions of the different groups within the matrix are considered as the most important phase of the analysis. Therefore the positions of the groups are discussed after the matrix has been made. Consequently, variables were changed if necessary to correct the position within the matrix. During the discussion it was concluded that only the scores on supply risk(s) needed to be adapted in order to adjust the position on the matrix.

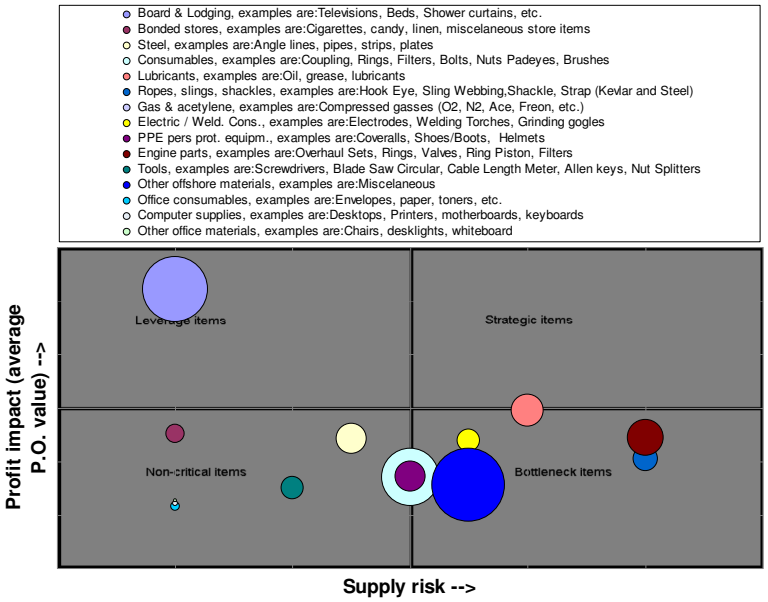

Figure 20: Purchase portfolio analysis

The portfolio analysis reveals that none of the groups of purchase items lie in the so called strategic quadrant as defined by Kraljic. Most items have not much impact on HMC's profitability and thus depending on the supply risk are non critical, or bottleneck items. A small portion of the purchase portfolio can be labeled as leverage items.

Currently all items are treated similar and no differentiation has been made between categories when it comes to a purchasing approach. The sourcing approach which is currently used could be categorized as a bottleneck sourcing approach; "serving the factory".

3.2.4 Vendor analysis

As described earlier, problems with processing PR's most often occurs with vendors which are used infrequently. Therefore it is useful to gain more insight in the how many suppliers are used for vessel purchases.

Vessel generated purchases are procured via 576 vendors.Table 8 shows the percentages of suppliers which are responsible for a given percentage of spend. The same has been done for PO's and line items in both categories.

	80 % of total spend	80 % of all P.O.'s	80 % of all line items
Number of suppliers vessel generated purchases	12%	24%	10%

Table 8: Pareto analysis vessel purchasing group

Furthermore the accumulated percentage of total spends as a percentage of the total amount of vendors is depicted in Figure 21. In that same graph the associated percentages of line items and PO's are depicted.

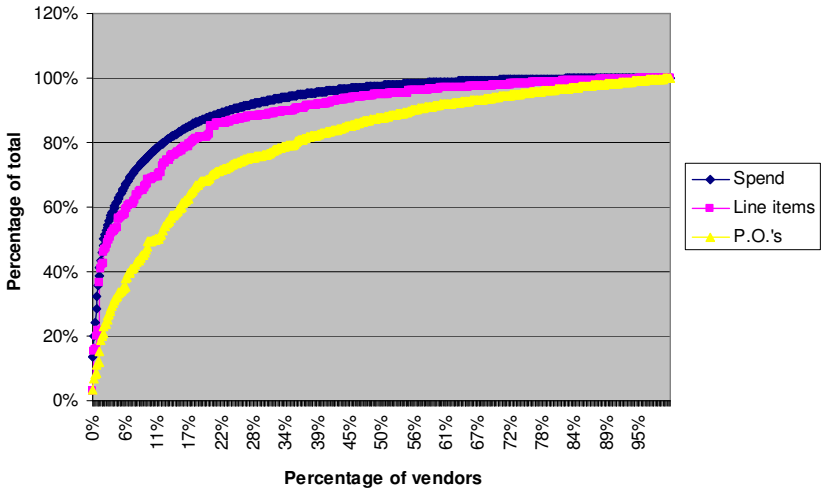

Figure 21: Pareto analysis vessel purchasing

From the information supplied above can be deducted that for the vessel generated purchases the vast majority of suppliers receive few orders with a low total value and few order lines. This implicates that a lot of items are purchased from a relatively small group of vendors and a lot of vendors are used infrequent which receive not many orders. When one relates the PO's which cause the process of processing PO's to hamper to the 20 and 80 percent groups of vendors, one can state that the majority of PO's which need additional time to process comes from the 80 % group which receives the least number PO's and spend.

The top 10 suppliers within vessel purchasing are also categorized in a matrix. The supply risk in this figure mainly concerns the amount of alternative suppliers exists who can substitute a certain supplier with a certain package of supplies. The result of this analysis is depicted in Figure 22.

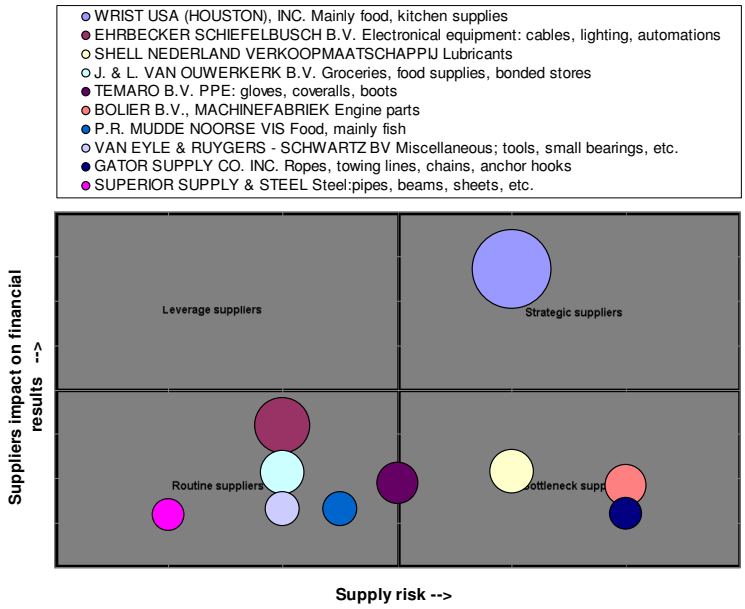

Figure 22: Vendor portfolio analysis

As can be derived from Figure 22 above, from all top 10 suppliers most do not have a large impact on financial result. And the largest portion of suppliers can be interchanged with alternative suppliers. Therefore none of the suppliers fall in the strategic quadrant. This supplies extra indications that a sourcing strategy adapted to the position on the matrix would be appropriate.

3.3 Diagnosis

In the departmental analysis for the vessel purchasing group was identified that the costs associated with processing a PR are high, especially considering the average value of the items purchased. The focused study confirms this notion. From the analysis can be concluded that the average costs for processing PO's is high considering the relatively low costs for a large portion of items. These findings underpin the notion that process costs take up a large portion of TCO for these goods (as identified in the preliminary analysis within each group).

Furthermore, the process cost analysis revealed that the number of suppliers was one of the main drivers for increasing process costs since; the number of suppliers has a direct impact on procurement activities, i.e. finding, negotiating and making contracts with suppliers, and vendor management. And it was found that as long as the number of suppliers stays unchanged it is difficult to reduce the number of orders, deliveries and invoices. In addition, educating the suppliers in order to improve the administrative processes to reduce the amount of incomplete or incorrect documents would be impossible if the number remains on the current level. Therefore a supplier management and reduction program can be fruitful.

In addition, the focused analysis revealed that the current sourcing strategy could be categorized as a strategy which is most applicable for bottleneck items. Since there is also a large amount of spend in the leverage and non-critical quadrants, an adapted sourcing strategy for these items could be beneficial. Considering the findings within HMC and in academic literature potential directions for change could be:

Non critical items:

- Frame agreements, in order to reduce process costs and increase leveraging power for relatively low value items, which are procured on a frequent basis (e.g. Andersen et al., 1999; Mohanty and Deshmukh, 2000; DMCC; DC).
- Automation of the ordering processes (catalogues systems, EDI) in order to reduce process costs for low value items which fall in the routine quadrant (e.g. Angeles, 2007; Davila et al., 2003; Harink, 2004).

Leverage items:

- eRAs for the more expensive leverage items. This potentially spurs a greater market transparency, reach to an increased number of potential suppliers through lower barriers for market entrance. Hence this possibly could also lead to shortened process cycle times (e.g. Chaffey, 2004; Harink, 2004; Heijboer and Telgen, 2002). Hence, this solution could also be beneficial for other purchasing groups besides the vessel purchasing group considering the findings from the departmental study.

General recommendations:

- Vendor management; in order to reduce errors in the procurement process and improve quality of delivery associated with certain vendors (e.g. Degraeve et al., 2000; Lamming et al., 1996).
- Supply base reduction; a smaller supply base is easier to manage and educate (e.g., Cousins, 1999; Dowlatshahi, 2000).
- Creating PR's where the items are grouped per category, which consequently results in a more efficient (RFQ) process.
- Managing of the new material management system in such a way which enables improved information availability per item and built a supply history, etc. Furthermore this system could also enable specifying PR's on the basis of specifications instead of item numbers of vendors, as is the case now.

The above suggested directions for change were discussed with the stake holders. Putting more effort in educating requisitioners in providing better PR's will be started with immediately. Managing the new material management system is not possible yet, since the system is still under construction. It is possible to design a plan for how this system should be managed in the future, but is considered not the conceptual solution design with the highest potential at this moment, and therefore will not be delineated on. The automation of purchasing processes is perceived to be a valuable direction for a conceptual solution design. In order to enable automation of purchase processes in most instances it is necessary to have frame agreements in place. Therefore in combination with the potential positive effects of frame agreements in itself the

decision is made to discuss this as conceptual solution. As discussed earlier the number of suppliers determine the amount of time and cost the PR process costs, therefore supply base reduction and vendor management are chosen as a mean which will be treated on a conceptual design level. Finally, eRAs were found to be an appropriate mean to decrease direct acquisition costs also for frame agreements. Therefore a conceptual solution design will be provided in the sequential chapter for:

- Frame agreements.
- Automation of ordering processes:
    - Electronic Data Interchange.
    - E-ordering.
- eRAs.
- Supply base reduction and vendor management.

4 Conceptual designs

When a company has identified certain problem areas or aspects which can be improved in the current situation, a solution design may be sought after. A solution design in procurement can be directed to gain improvements for the company studied in the following directions (Van Weele "PS kring" meeting 06-05-'08):

1. Decreasing TCO (indirect and direct costs incurred due to procurement activities).
2. Gaining control over spend and improve insights.
3. Improving convenience in the use of systems and procedures.

In HMC's situation the most important focus of a direction for improvement is the reduction of process costs for the vessel purchasing group, and direct acquisition costs in the whole group. Gaining control over spend and improving convenience in the use of the system will also be taken into account, but this is not the focal point of HMC and these conceptual designs. Obviously during the design of the conceptual solutions HMC's requirements as stated in section 1.2 will be taken into account.

First the impact of and a design for the use of frame agreements will be described in this chapter. Next, the potential consequences of the automation of processes will be briefly described. Then the effects of eRAs on TCO will be delineated, and finally the expected effects of vendor management and supply base reduction will be outlined.

4.1 Frame or blank order agreements

Frame agreements and blank order agreements could be used to reduce time spend on selecting suppliers and contracting them in the purchasing process. These process steps take up 23 % (or $ 86, -) of all process costs. Since bringing frame agreements in place takes much more effort compared to selecting and contracting a vendor for an individual contract, this is only favorable for goods or groups of items which are purchased on a regular basis.

Another option is to aim for direct costs improvements; this is only favorable for the orders with a high value and which are needed in large amounts during the year. This could be achieved by grouping non-critical items into a frame agreement; this will enable HMC to improve the buying power for those items.

Considering findings from literature and HMC's current situation the main aspects which have to be taken into account when selecting items or groups of items for frame agreements for HMC are:

- There have to be a considerable number of purchases per year in a group of items or of a single item for frame agreements to be beneficial. This since there are considerable costs associated with getting frame agreements in place and managing them properly. Currently, there are three MEM systems in place, this implicates that linking frame agreement prices to items is a time consuming

task, since this has to be done three times. Therefore the full benefits can only be reaped when the MEM systems are merged into a single database.

- When the total value of all items which one has planned to capture in a frame agreement is large, one is able increase buying power. This potential benefit which can be obtained by HMC.
- There have to be vendors who are able to supply the package of goods under a certain predefined service level (supplying within a certain timeframe, quality of items, etc.).
- Specifications of the items can be described (quite) accurately and don't change too much in time.

From the current portfolio of items purchased at HMC's vessel purchasing group, Personal Protective Equipment (PPE's) is the one which is the most obvious one to start with (See, Table 9 on page 3). Furthermore, PPE's (as can be seen in Table 9 on page 3) meet the prerequisite conditions as stated above:

- The category PPE's and subcategories of PPE's consists of a limited number of items, and therefore it takes less time to register prices and conditions in the MEM system.
- The total value of the items annually purchased in this group of items is high.
- Specifications can be described and registered (quite) accurately. Hence, specifications can easily be based on quality and safety standards and regulations, size standards, etc.
- There are enough vendors who can supply qualified PPE's.

PPE Personal Protective Equipment

	Value:	Number of P.O.'s:	Number of order lines	Different items	Number of items	Number of vendors
Shoes and boots	$ 437.306	117	372	137	7261	7
Gloves	$ 311.101	109	164	50	196390	17
Coverall's	$ 388.615	111	421	100	11169	7
Jackets	$ 69.005	48	90	40	2640	11
Trousers	$ 31.047	24	43	21	1183	5
Helmets	$ 74.478	56	93	38	15632	14
Goggles and glasses	$ 27.081	20	44	30	11562	9
Potential annual frame agreement(s) value	**$ 1.338.633**					
Total PPE	$ 3.532.095	534	1680	629	519143	41

Table 9: Personal Protective Equipment breakdown (2007)

Other groups of items for which it is potentially fruitful to source them via frame agreements are shown in Table 10.

Other

	Value:	Number of P.O.'s:	Number of order lines	Different items	Number of vendors
Standard tools	$ 1.200.000	485	2460	137	7
Small slings and grommets (up to 200 ton)	$ 900.000	+-200	+-300	250	
Small shackles (up to 200 ton)	$ 200.000	+-100	+-400	200	
Hooks	$ 100.000	+-100	+-200	75	

Table 10: Other potential groups of items for which frame agreements could be fruitful

It is difficult to predict what impact bundling items in frame agreements has on direct acquisition costs. DMCC reported on considerable direct acquisition costs reductions. This is without a doubt a very indefinable amount or percentage. Based on DMCC's reaction in combination with a quick inquiry on potential direct costs savings together with my company supervisor resulted in a conservative figure of 5 % which can be saved on PPE by sourcing them via frame agreements instead of via current sourcing methods. This results in a direct acquisition costs saving for the selected group of PPE's of $ 65 K annually.

For the impact on the amount of time which will be saved in processing PR's, and the time it will take to set up and manage frame agreements counts the same that it is hard to predict what time and costs can be saved on the bottom line Therefore this has not been taken into account for this conceptual solution. Hence, in order to reap the full benefits from utilizing frame agreements and make this a success on the long run a proper change plan has to be designed.

4.2 Automation of ordering processes

As discussed in chapter 2 the automation of the ordering process can be done in different manners. Considering the theoretical findings and HMC's current situation only catalogue systems and electronic data interchange (EDI) modes of automation will be potentially fruitful and therefore those will only be treated in this section.

4.2.1 EDI

Direct or indirect linking of HMC's ERP systems with that of the supplying parties will reduce direct costs to process a PO for those items where a linking has been realized for. Since, there are considerable costs associated with the realization of the linking of ERP systems and negotiations of terms, conditions, and price levels of the items for which the linking is realized this is only interesting for items and vendors for which a large number of PO's are made.

Furthermore, the step ordering in the current procurement process only takes a minimum amount of effort (5 % of the costs), automation of this process will only impact on that 5 % of process costs, therefore there has to be a very large reduction in effort within that process step in combination with a large number of purchases in orders for implementation of EDI to be beneficial. Another important benefit of utilizing such a system is that purchasing employees can focus more on tactical and strategic aspects of purchasing than on the operational ones.

An important precondition which has to be met in order to smoothly implement EDI (DMCC) is a well developed material database (history, uniform codes). This is needed to link both the supplier's and buyer's database with items. Currently HMC is merging all material databases from all vessels into one and changing to another software system for managing the database and processes. When the new database is operational and some history on consumption rates becomes available the use of EDI can be fruitful for the following vendors/categories of spend:

Vendor name:	Product category	PO value	POs	Order items	RFQs	RFQ items
	Electronic equipment and spare parts	$ 2.958.273	230	2762	334	2922
	Tools, bearings, sealings	$ 864.878	197	3448	320	3813
	PPE	$ 1.151.951	152	932	146	799

Table 11: Categories and vendors for which EDI could be a fruitful solution

In choosing the categories and vendors, there has been taken into account how equipped these parties are when it comes to using and implementing IT solutions in their supply chain, and daily operations. When EDI is going to be utilized to realize costs savings in the procurement process at HMC, the following approach is suggested:

- Choose more parties to start negotiations with to source a portion of the portfolio from.
- Decide on what portion from a category can be sourced via EDI, based on more advanced information from the new MEM system.
- Take into account what the future implications are regarding, switching costs, strategic exposure costs, etc.
- Costs of linking ERP systems depend highly on the type and how software is used in both companies, therefore one need to take into account what the costs are for the different options a company has.

Since costs associated with implementing EDI can vary widely (Eriks and DMCC) depending on the future partner's software readiness and software package utilized, it is hard to make predictions in the direction of what future cost reductions can be realized.

4.2.2 E-ordering

As counts for EDI an e-ordering system is based on a frame agreement where prices, delivery time, site, minimum order quantities, service levels, etc. are settled with between vendor and buyer. Therefore the e-ordering system impacts on the ordering process which takes up to 5 % of the current process. Only when the current process from specifications till the ordering process will be changed, this could have more impact than the current $ 12, - for example when the end-users (on the vessels) would themselves order goods. Currently, most stakeholders do not embrace a future situation where for example end users on the vessels themselves order certain goods. This has to do with the fact that the process is less controlled compared to the current situation as it is now, and it would be easier to commit fraud, etc. Hence, a future situation where end users directly make a PR and PO would violate the present business policies and therefore this project's requirements as set by HMC.

Hence, the offices use a catalogue system for ordering office supplies. Via this system by All Office, certain approved employees can order office supplies.

4.3 eRAs

eRAs most important benefit is the potential reduction of direct acquisition costs (as suggested in chapter 2). Since HMC' largest costs are direct acquisition costs of goods and services this could be a beneficial tool for HMC, especially when one takes into

account the findings from chapter 3, that the largest TCO costs are direct acquisition costs for all groups (except vessel purchasing). Nonetheless, for vessel purchasing eRAs can be used as a mean for coming to a frame agreement prices.

More concrete the goods and services where eRAs can be used for acquiring them, are:

- **Vessel purchasing**
  - Frame agreements, as suggested in the former section.
  - Future frame agreements for non critical items at the vessel purchase department as suggested: PPE, office supplies, office cleaning services (€ 350 K annually), security services (€ 840 K annually). Note that the spend generated at general affairs are made in Euro's. Since, the vendors for these items are all located in the Netherlands the prices are not converted to dollar prices.
- **Non vessel purchasing (projects and equipment maintenance, etc.):**
  - Anchor wires ($ 1.2 M annually).
- **Floating equipment:**
  - North Sea area, 50-75 ton bollard pull tugs $ 0,6 M annually.
  - Gulf Of Mexico 50 ton bollard pull tugs $ 5 M annually.
- **Subcontracting fabricating items** only if enough vendors are available in the predefined region, and supplier relationships are expected not to be harmed to severely by an auction. Items which are most suitable for auctioning are:
  - Barge cleaning services, annually $ 2 M annually.
  - Grillage and sea fastenings $ 1,5 M annually.
  - Materials (Piping material, Lifting frames, spreader bars) $ 2.4 M annually.
- **EPIC** (although not part of the first part of this study, this group can potentially also benefit from utilizing eRAs):
  - Non critical and leverage items: Materials like: pipes for pipelines, valves, etc. Due to the characteristics of EPIC projects the collective value which annually potentially can be sourced via eRAs will exceed $ 10 M annually.

The total value of the items which are potentially eRAable, as suggested above exceeds $ 24 M, annually. It is hard to predict what the exact reductions in direct acquisition costs will be when eRAs are used as a mean for negotiating prices, instead of the use of RFQ's and negotiation processes. Nonetheless on the basis of findings from literature and business practice, one can expect that large gains can be made. Hence, even with a low percentage (of for example 5 %) in reduction the absolute reduction in price is high due to the large ($ 1.2 M) collective value involved. Note that before eRAs can be used as a procurement tool proper and extensive upfront preparations have to be conducted and potential pitfalls (as suggested in chapter 2) have to be taken into account in order to let those eRAs result in the desired outcome without any adverse side effects.

4.4 Supply base reduction and vendor management

When current supplier base will be managed in a more active manner TCO can be reduced since this most likely reduces errors in the process of processing PR's.

Furthermore, when vendors are rated on the basis of their performance in different aspects (quality of goods, invoicing, delivery time accuracy, availability, etc.) procurement officers can take this into account (more easily) when choosing for a supplier. Especially when vendors are rated in all phases of the process since procurement officers do not always have all/full information on the impact particular suppliers have on all processes. Furthermore, with the gathered information per vendor, vendors can be developed and educated better.

Since there are currently such a large number of vendors where HMC conducts business with, it is difficult to manage all those suppliers. Furthermore with a large number of suppliers it is more difficult to manage these suppliers, and as has been found in the analysis; the most errors in the process are related to those vendors who receive the least number of PO's. Therefore it is beneficial for HMC to reduce the number of suppliers in order to enable streamlining of business processes, and educating suppliers, etc.

Currently no program is in place to actively manage the vendor database or reduce current supply base. In the case of HMC, a supply base reduction program in combination with a vendor management program can further reduce the number of errors in the procurement process, improve quality of goods, increase general service levels, and decrease TCO. Together with the procurement manager an indication has been made in the expected gains which can be made by implementation of supply base reduction and vendor management:

- Direct acquisition costs by consolidation of spend: $ 40 K.
- Decrease in administrative burden (less incorrect invoices and maybe electronic invoices, less time spend on introducing new suppliers): $ 20 K.
- Improved overall quality, and service levels (higher percentage of deliveries on time, deliveries on a correct place, deliveries packaged properly; package material, pallets, per vessel) : $ 20 K.

4.5 Conclusions

As discussed in the former sections of this chapter; due to the current IT systems, procedures, and working methods it is currently not possible to implement EDI or E-ordering. When the new MEM system is in place, this will enable HMC to implement EDI solutions. E-ordering will only be possible and profitable when authorization and procedures will be changed in such a way that end users can order items themselves. Since, it is currently undesirable to change the current authorization procedures implementation of e-catalogue systems is undesirable at this moment.

Three directions for change can be beneficial, namely:

- Frame agreements: frame agreements can save a forecasted $ 65 K annually. Furthermore, when first frame agreements are put into effect, it is possible to later automate the order process by means of electronic data interchanges with a selected number of suppliers to decrease costs associated with the process.
- Supply base reduction and vendor management: This author advises to start monitoring current vendors more actively and reduce the number of vendors

when possible in an appropriate manner. As suggested this author thinks this will result in process as well as direct acquisition costs savings due to bundling and a decrease in process delays and improved quality and service levels. Expected annual gains are estimated to be $ 80 K.

- eRAs: As suggested the expected gains which can be made within HMC by decreasing the direct acquisition costs by means of auctions amounts up to $ 1.2 M annually. The costs of implementing auction software are very low compared to the gains which it brings (DMCC, DC).

A trade off has to be made where to focus on in the solution design. The decision has been made to decide on the basis of a costs benefit trade off. Table 12 shows the expected costs and returns of each potential solution on an annual basis. Costs for the different solutions were estimated by multiplying the expected workload in FTE by the annual costs per FTE. The workload per solution design was approximated in consultation with my company supervisors and departmental manager. Hence for the option e-reversed auctioning expenses for a for a software package have been added.

The potential benefits are divided by the total costs associated with each solution which results in Return On Investments (ROI) per conceptual design. As can be derived from Table 12, all solution designs have a ROI higher than 1, which means that the gains exceed the investments on the long run (time and interest factors not taken into account). When comparing the alternative conceptual designs, one can conclude that introducing eRAs probably bring the largest gains when it comes to reducing TCO at HMC and ROI. Due to the large potential for eRAs at HMC the author in consultation with the company and university supervisors decided to focus the solution design on eRAs.

	Annual software fee	Expected required personel (in FTE per year)	Year expenses per FTE	Labour costs (annually)	Costs total (per year)	Potential gains (yearly)	ROI
Supply base reduction	$ -	0.5	$ 101,237	$ 50,619	$ 50,619	$ 80,000	1.6
Frame agreements	$ -	0.33	$ 101,237	$ 33,746	$ 33,746	$ 65,000	1.9
Reverse acutions [1]	$ 10,500	1.5	$ 101,237	$ 151,856	$ 162,356	$ 1,200,000	7.4

[1] Costs for software license € 3000,- + € 500 per auction times 15 (Vendor: Quell)

Table 12: Cost-benefit analysis of the different conceptual solutions

5 Solution design

eRAs have been used quite extensively during the last decades, and much has been reported on eRAs (e.g., Beall et al., 2003). The most critical aspect of eRAs are the upfront planning and decisions made on how the eRA will be executed. This determines whether the event becomes successful or a disaster (e.g., Harink, 2003; Beall et al., 2003). Therefore this chapter deals with the decisions HMC has to make upfront of the actual eRA event. In this chapter answers will be supplied to the following key challenges:

- *Which contracts are best suited for eRAing?*
- *What are the design variables of an eRA and when should a particular eRA design be used?*
- *Planning and designing eRAs at HMC.*
- *What are the prerequisites when it comes to software implementation?*
- *What is the most appropriate ERA software package for HMC?*
- *Evaluation of the solution design for HMC.*

5.1 Screening for auctionable goods

As discussed in chapter 2, items which can be labeled as leverage and routine products are easiest to purchase via eRAs, but not for all items this is profitable. Furthermore, more complex and specialized goods or services can also be sourced via eRAs, but need more attention when it comes to upfront planning, market analysis, structure of the order, and specification of the item. Therefore one cannot strictly say what type of items - when it comes to a classification on the Kraljic Matrix - can or cannot be procured via eRAs. Especially, when considering the fact that the more experienced a company is in using eRAs the better it is equipped to conduct eRAs and is able to put eRAs into use for more complex contracts.

Therefore, HMC should monitor what is being purchased and pre-select contracts for which it is potentially profitable to eRA. Which variables determine whether it is rewarding to eRA a contract depends on the goal of the eRA; a process improvement tool or as a tool for reducing direct acquisition costs. Independent whether the goal is speeding up the procurement process or decreasing direct acquisition costs, the following has to hold:

- The content of the contract (goods, services or a combination of both) need to be specifiable in appropriate detail. When the content of the contract will be retrieved from OEMs (Original Equipment Manufacturer) or service provider, it has to be possible to specify the content according to; drawings, dimensions, service levels, quality standards (e.g. NEN, ISO, DIN), etc. With this information the OEM's or service provider needs to be able to define what the product exactly is, and calculate at what price and conditions they can deliver those specific items. When the goods are retrieved from wholesalers, intermediaries or a Value Added Reseller (VAR), the goods can be specified according to manufacturer's part numbers. Based on this information the wholesaler or intermediary has to be able to define what kind of product(s) the buying party needs, and whether they can supply it or supply alternative products, against what price. Furthermore for both counts that other conditions

(not directly related to the good or service) like payment terms, accountability etc. need to be treated in detail within the eRA contract.

- Since, it has been found that the whole process from upfront planning to actually executing the eRA to contracting takes more time compared to an RFx process or trade negotiations. The actual time spend on negotiating on the other hand is much less compared to RFx and trade negotiations for large contracts. Considering the time needed for upfront planning and preparing the eRA event, one needs to take into account that there has to be sufficient time for preparing, and executing the eRA. In the section 5.3 Upfront planning and executing eRAs at HMC this will be treated in more detail (what elements need to be taken into account and what time each element will take).

When the purpose of an eRA is improving and speeding up the negotiation process, one should balance the positive and negative effects an eRA potentially has on the acquisition process compared to an RFx process or trade negotiations. Of course also the costs associated with both modes of negotiating and contracting have to be taken into account. A formula for making a trade off between the different possible modes is hard if not impossible to make. But, most often the goal is to speed up the process of price setting where the impact of an eRA can be estimated. Then together with the time and costs of upfront preparations and planning of all possible negotiation strategies a trade off can be made whether the decrease in time spend on negotiating is worth the extra time and money spend upfront.

For eRA's to be beneficial for the purpose of reducing TCO for certain items and services, the following additional criteria have to be met:

- Since there are considerable time and costs associated with conducting an eRA, the event has to bring in enough benefits when it comes to reducing TCO to outweigh the costs of conducting one. As a first threshold value a minimum contract value of $ 100 K is set (as discussed in section 2.4.3.3).
- As delineated on in section 2.4.3.3. all kind of issues (delivery, quality, bankruptcy etc.) can arise when vendors have been awarded a contract below their cost price(s). Therefore one needs to make sure that for that specific item in a specific market vendors have slack margins, and are able to drop their prices sufficiently before hitting their cost prices
- There have to be a minimum number of 4 qualified vendors willing to participate actively in the eRA in order to make sure that the auction mechanism works. As discussed in section 2.4.3.3, when less then 4 vendors participate there is most likely not enough competition and vendors are not triggered to lower their prices, since no participant does or just in a minimally. Hence, a maximum number of participating vendors has not been found, but one can argue that when "too much" vendors participate that the perceived chance of getting awarded the contract declines. Therefore one needs to monitor and determine at what number this sets in.

For the purpose of determining whether it could be fruitful to use eRA's as a procurement tool and screen for potential contracts a tool has been designed. When

constructing a tool for this purpose, it is key to single out as much contracts with the first variable where will be screened on. In this manner the least effort has to be put in screening for contracts, since the minimal numbers of contracts have to be screened on sequential variables. In Figure 22 this decision model is presented which can be of help in deciding to use an eRA or not, and is based on the preceding. Hence, as discussed the basis for this model originates from the interviews held (DC, DMCC, Quel), and academic literature (e.g. Beal, et al. 2003, Jap, 2002).

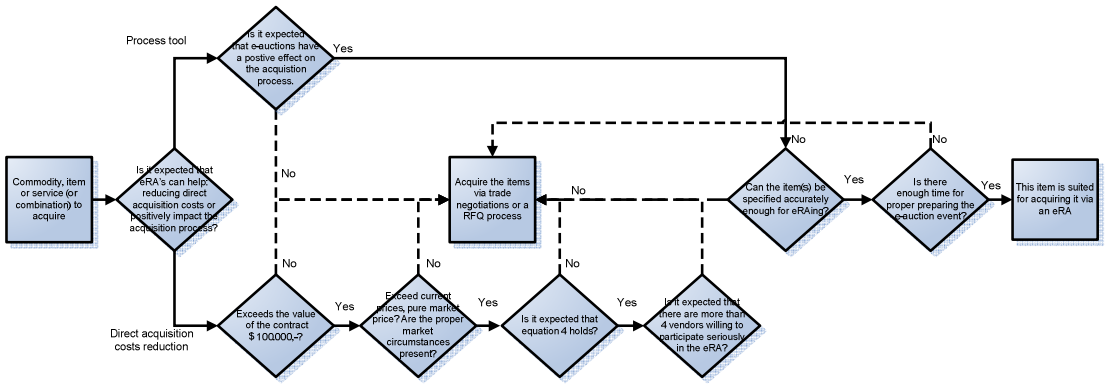

Figure 23: Decision model to eRA or not

$$E + Ce < TCORFx + RFx$$
$$E = e - auction\ event\ \cos ts$$
$$TCOeRA = Expected\ \ TCO\ \ of\ \ the\ \ goods\ \ when\ acquired\ \ via\ \ an\ \ eRA$$
$$TCORFx = Expected\ \ TCO\ \ of\ \ the\ \ goods\ \ when\ acquired\ \ via\ \ an\ \ RFx\ process\ or\ trade\ negotiations$$
$$RFx = Costs\ of\ the\ RFx\ process\ or\ trade\ negotiations$$

Equation 4: Costs benefit trade off of an ERA and RFx or trade negotiations

5.2 *eRA design considerations*

As discussed in section 2.4.3.3 four dimensions determine the eRA design. On the basis of the interviews held (DC, DMCC, Quel), and academic literature (e.g. Beal, et al. 2003, Jap, 2002) the impact of these variables has been determined and is described below. In accordance with the description of the impact of the variables, the appropriateness of choosing for a certain design is discussed. Consequently, a model has been provided which can support decision making on the design variables.

Price visibility, ranges from sealed bid to partial visible bids to full visibility of all information for all participating vendors:

- Sealed bids are used when the eRA is used as a process tool, and not for reducing direct acquisition costs.
- Partial visible prices are most suited when one aims at lowering prices where four different types can be distinguished:
    - Lowest bid or not; all vendor see whether they are the one with the best offer. This type is most appropriate when there is

expected that one supplier comes up with a considerably lower starting offer then the other's. By only showing whether a vendor placed the lowest bid or not, all vendors (except the one with the best offer) have an equal incentive to come up with a successive bid in order to become the vendor with the best offer.
    - Rank order; vendors see their position compared to the other vendors, where it is possible to show the other vendors ID's or not. Most suitable when it is expected that there is one lowest bidder who has to drag other vendor's prices down.
    - Lowest bid only; showing the lowest bid to all vendors. This will drag down prices by getting hesitating vendors who placed a bid close to the lowest activated. Hence, when the expected price differences are too large vendors won't get activated, then a rank order system is best.
    - Show all prices at that moment: spurring competition and market transparency for all vendors.
- Full visibility; when spurring competition among participants is the main goal; all prices have to be made visible for all participants together with the vendors ID's. This option also supplies the vendor with most valuable information. Not all situations allow this mode of price visibility due to the specific market circumstances or preferences of suppliers, etc.

Closing rules, two types of closing rules can be distinguished, but there is no evidence that one is better in certain conditions then others. In practice a combination is made between both modes. There are even examples of events where the closing rules were changed during the event, where all vendors collectively agreed upon (DMCC, DC):

- Closing if no successive biddings are made for a certain period of time.
- Closing the event at a predefined moment in time.
- Combination of both closing rules.

Award rules, are the rules which determine who will get awarded the contract which is being auctioned. The following can be distinguished:

- Price only, the only attribute which determine the winner of the auction is price. This is only appropriate when the price is the only or by far the largest determinant of TCO for a certain product.
- Price in combination with monetary and non monetary variables:
    - Knock-out criteria: vendors who want to participate in the eRA event, have to meet certain minimum requirements before they are permitted to participate in the eRA. The requirements can relate to the goods, service levels as well as to the issues like ISO certification, etc.
        - Monetary factors are used to include factors like switching costs, etc.
        - Non monetary factors are used to compensate vendors for factors like, quality of the goods, service levels, etc.

- Combination of monetary and non monetary factors.

Lotting strategy is the way in which the total amount of items which is being auctioned is split into lots:

- Market basket lotting strategy is used when many items in the same or similar commodity/purchase family or group need to be acquired. In this type the vendors can choose depending on their capabilities (e.g. products, service levels, geographic locations, etc.) which specific part of the total lot to bid on. It has been found that the more complex the lotting strategy the disappointing the results are.
- Individual lotting strategy is a strategy where a vendor can only bid for the whole lot/contract and not for a portion of it. This strategy is used when competition for the lot is high in one supply market, the product is complex and/or enough vendors are able to supply the entire lot.

To support decision making on the design of the eRA variables a graphical representation has been made (See Figure 24).

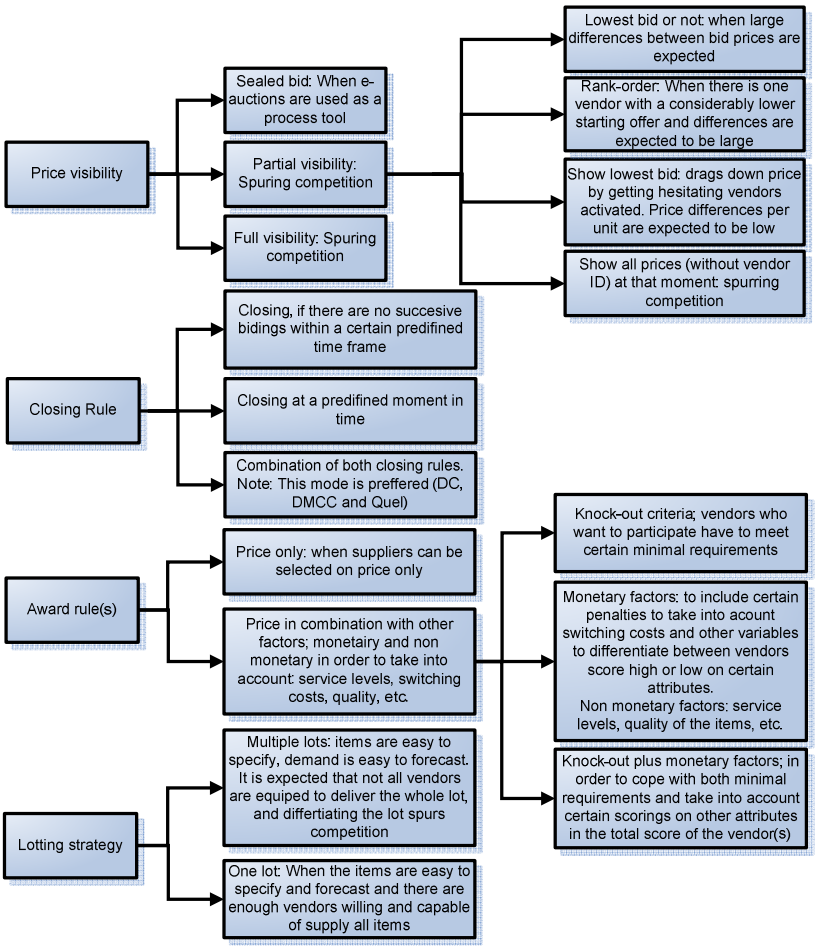

Figure 24: eRA design decisions and considerations

In order to provide support on how to use this decision tree, an example is provided to illustrate how this tool should be used. The example is about a year order of bolts and nuts, which is planned to be e-auctioned Note: this is a fictive example:

Price visibility: First one should determine how the prices of the vendors should be visible for the participating vendors. When the eRA is used as a process tool it is better to not show prices or position of competing vendors. In this case, the main goal is to decrease direct cost prices/TCO, therefore partial or full visibility of competitor bids is most appropriate. Current quotation prices do not deviate very much among vendors; therefore it is possible to show the lowest price or all prices in order to drag prices down. Since it is expected that full visibility will result in the best outcomes considering the market and subscribed vendors for this item, this is the most appropriate visibility strategy.

Closing rule: One can choose between closing the eRA after a predefined period in time, or after that a certain moment in time no successive biddings are received, or a combination of both. In this case the decision is made to use a combination of both. This to make sure that the event doesn't take longer then necessary (when vendors are not willing to come up with successive biddings after a certain eRA round), and vendors won't wait till the end of the eRA before starting with providing new and potentially successive bids.

Award rule(s): Awarding the contract will be done on the basis of price, knock-out criteria and monetary factors. This because HMC wants the future vendor to have a minimum stock of certain items, ISO 9001 certification, acceptance of HMC's terms and conditions (knock-out criteria), and take into account switching costs, and guaranteed service level, delivery time, policy around order flaws, (future) capabilities for e-invoicing (monetary variables). In this case the switching costs for new vendors will be added to their package prices. The other monetary variables will be used to reduce or increase the vendors bid, depending on their score on a certain element. The factor weights which are assigned to certain variables determine the 'scores' of the vendors. Since changing factor weights will in most instances change the vendor who will get awarded the contract. Therefore it is of eminent importance to determine the factor weights properly and evaluate their impact in a sensitivity analysis.

Lotting strategy: HMC will use a single lotting strategy for this item. This strategy is used since it is expected that there are enough vendors willing and capable of delivering the items within specifications, minimum required service levels and on the locations as requested by HMC. Furthermore, it is preferable that only one vendor will supply this commodity during the contract period.

5.3 *Upfront planning and executing eRAs at HMC*

According to the findings from literature (e.g. Beall et al., 2003; Jap, 2002; Reunis, 2007; Harink, 2003), and from the interviews held at offshore dredging and marine contracting companies (at DC, DMCC and Quel), a number of steps have been identified in the process of e-reversed auctioning. The process steps are described below; where HMC's current situation and processes have been taken into account in determining the most appropriate order and number of steps for HMC. Furthermore the decision trees as introduced in the former section can help the responsible persons within HMC in the decision making process on executing eRA's.

1. First one needs to filter out those contracts for which an eRA is potentially the best contracting method. The decision has to be made on the basis of the recommendations in section 5.1 and with the help of the suggested decision model (See Figure 23).
2. When the decision has been made to eRA the item, a planning has to be made for preparations, inviting and preparing vendors, executing the auction event itself, etc. The steps described below should be part of such a planning.
3. Determine specifications of the item(s), and terms and conditions (quality, quantity, associated minimum service level, delivery interval, delivery address, etc.).
4. Search for qualified suppliers for the goods or services. Take into account that a minimum of 4 vendors have to be qualified and willing to participate actively in the eRA when reduction of direct acquisition costs is the main goal. The number of 4 participants is a minimum, since it has been found that there will be not much competition in an eRA where less then 4 vendors will actively participate.
5. Determine the eRA design. A decision tree has been made to support choosing the proper values for all variables (see Figure 24).
6. Execute a sensitivity analysis on the factor weights to calculate vendor's 'scores' (determine the impact of the auctioning award rules). When necessary adjust the eRA award rules to make them better suite their purpose.
7. Design rules and procedures when due to whatever circumstance (power shut down, internet problems, etc.) HMC is not able to proceed with the eRA event or participants have to stop, etc. An example of a rule could be; postpone the eRA for 30 minutes when one of the participants is not able to submit a bid within the bidding cycle of for example 5 minutes.
8. Invite vendors for the eRA event. Supply those vendors who are willing to participate, the appropriate specifications of the items at stake. Furthermore, communicate the auction rules to the potential participants, and educate those vendors who are willing to participate on: eRA procedures and the software used.
9. Reserve time for questions and answers from vendors on: Specifications, auction rules, etc. Hence, make sure that every participating vendor is informed on the information as a result from the different question and answer sessions.
10. Reserve time after step 9 in which the vendors can calculate their prices, and determine their bidding strategy according the provided information. In this

stage the vendors also have to come up with a quotation, which is the starting bid for the eRA for that vendor.

11. Execution of the eRA event.
12. Determine which vendor has ended as the most profitable vendor considering the direct acquisition price biddings in combination with the other auction rules.
13. Award and sign contract with most promising vendor(s).
14. Post-event analysis of the eRA event (lessons learned, etc.). Provide timely and constructive feedback to both award winner(s) and losers. This will most likely have a positive impact on the buyer-supplier relationships. After finishing this stage start with process step 1, taking into account all lessons learned from former events.

As stated in the first step of the process, contracts for goods and services have to be analyzed on the appropriateness of an eRA as a procurement tool for that particular contract. When an eRA is appropriate, the procurement officer and responsible eRA manager will decide on conducting an eRA for that specific contract (or not). When the decision has been made to conduct an eRA, the process will continue with step 2. After step 12 has been executed the PO or frame agreement can be processed in the ERP system (SAP), and the regular sourcing process will continue from here. When the decision is made not to eRA the contract, the contract will be awarded with an RFx process or trade negotiations.

Compared to the regular acquisition process, the RFx process is replaced with the eRA event. Therefore e-reversed auctioning has little impact on the sourcing process itself; it only takes more effort in preparing the eRA event, and gathering more detailed information on and registration of specification of the items beforehand. Considering the extra costs and time needed for e-reversed auctioning one has to bear in mind that Equation 4 has to hold, and time is available to prepare for and execute all steps required for successfully executing an eRA event.

5.4 *Prerequisites for implementation*

eRAs as the name already suggest are auctions which are held via internet. A prerequisite which has to be met in order to use eRAs is a proper internet connection which is suitable for running the internet software system. HMC's information system and internet connection's specifications exceed the minimum requirements for operating such software (source: Quel). When considering the technology aspects only the vendor's information systems and internet connection can be a bottleneck. From the current supply base there are a considerable amount of vendors (especially US based vendors) from which the information system is most likely not suited for eRAs. The same counts for the personnel who have to work with the eRA software. The largest portion of HMC's personnel has a bachelor degree or higher, and is quite skilled and open for using new software programs. This does not necessarily count for all vendors in HMC's current database. Although, most eRA software programs are user-friendly and simple to use, vendor's IT skills and readiness have to be taken into account when selecting, and educating vendors. Current vendors who do not have the

technological resources and suitable personnel for participating in an eRA have to be supported, to make sure that they are not by-passed only due to these limitations.

5.5 *The most appropriate eRA software package*

eRAs can be held in different varieties and with different software packages. The numbers of vendors who deliver eRA software are numerous. A decision therefore has to be made in how the ideal auction software should work, in combination with the associated costs per software package. For this purpose a number of suppliers of eRA software and services were contacted, and information was collected on their services, and associated costs. The collected information has been grouped and labeled in Table 24 in Appendix VII: eRA software and service suppliers.

When calculating the costs for the software package the number of eRAs on an annual basis has been approximated to be 15 (based on field observations). This number will most likely not be exceeded within the first 3 years (DC, DMCC). As can be derived from that table the supplier with the most extensive service and economically attractive offer is Quel, especially considering the notion that in the first year not that many auctions will be held. Therefore this author recommends choosing Quel as the supplier of the service for HMC.

5.6 *Evaluation of the solution design*

As has been discussed in section 1.2, the solution design has to comply with HMC's requirements. The suitability of the recommended solution is discussed below according to the requirements as set by HMC:

Functional requirements:

- *Realization of the solution should solve the business problem: In this business case it is reducing TCO, by means of innovative procurement tools.* As can be derived from the analysis e-reversed auctioning complies with both requirements since it reduces TCO and is one of the latest procurement tools, and thus can be regarded as innovative.
- *The benefits of the potential solution should exceed the costs of it:* The anticipated ROI of a solution should exceed at least 1. As mentioned in the antecedent section the solution eRAs has a ROI of 7.4 and thus meets this requirement well.

User requirements:

- *The people involved should have the competences to work in the new situation, and with the new tools, procedures, etc.* 70 % of the department's employees have a bachelor degree from which 60 % also have a master degree. Most employees are highly motivated and eager to learn. Therefore one can assume that with a minimum training effort most employees will be able to work with the new tool. As discussed above in the former section, readiness of an average vendor for eRA's needs some additional attention.
- *The new system should be user-friendly.* From interviewed experts who have extensive experience in using eRA software, can be deducted that most eRA software systems are quite user-friendly and easy to use.

Boundary conditions:

- *The system should comply with HMC's business ethics, legal requirements, including those on safety and health.*

  Health and safety requirements are not an issue when using eRA software, since the software and the use of it does not directly bring along health and safety issues. On the other hand indirectly it can: switching suppliers, reduction of vendor's margins, etc. can result in a decrease in product quality for instance, which consequently can bring health and safety risks. These potential risks can be obviated by getting the proper counter measures in place: monitoring quality of suppliers etc.

  Legal issues have to be dealt with in the use of the software, since e-reversed auctioning is a way of contracting, where legal issues play an important role. The legal issues can easily be dealt with, with the help of HMC's legal department as has been done at the case companies DMCC, and DC.

  When it comes to the business ethics which are used at HMC for conducting business with its trade partners, the document: Supplier code of conduct (provided in: Appendix VII: HMC's supplier code of conduct) is leading. Considering the content of this document, the following can be said about eRA's:

  - Ethical dealings: When using eRAs the awarding process is very transparent: Awarding rules are described accurately, and the bidding process itself can be traced back if necessary. Therefore eRAs leave little room for bribery, kickbacks, corruption and other prohibited business practices.
  - Supplier diversity: Since the minimum number of vendors per eRA is set to 4, and most likely new vendors are added to the list of potential vendor for a certain item. Therefore eRAs will most likely spur supplier diversity.
  - Company resources are the tangible and intangible goods which comprises HMC. This is an aspect which has to be taken into account when in the future items will be e-auctioned for which the vendors need specific and confidential information in order to raise their bids. Before information or goods are provided to the participants of an eRA, HMC needs to make sure that vendors will deal with it appropriately. Hence, when a contract is awarded via an eRA for which this is relevant, this aspect has to be incorporated in step 8 of the 14 step e-auction planning and preparation process.
  - Accounting and business records; this issue is dealt with in the standard model agreements, therefore eRA's will not or very little impact on this aspect.
  - Conflict of Interests; when implementing eRAs this will most likely not impact the interests of individuals involved.

- Brand and trademarks: When new vendors are introduced due to eRAs those vendors have to be educated in order that they will properly reinforce and strengthen the HMC brand and use of the HMC trademark.
- Environmental and safety issues: New vendors have to be educated on the Environmental and safety standards HMC uses. Hence, this counts for all parties who get introduced as a new vendor for HMC.

- The system should fit within the present company culture. The current company culture when it comes to procurement can be described as follows: Goods and services better can be expensive and qualitatively excellent, then less expensive with moderate quality. Furthermore buyer supplier relationships are considered to be very important. eRAs when not used properly can harm buyer-supplier relationships. Furthermore, quality and service levels can potentially decline as a result decreased supplier margins. Therefore extra attention needs to be given to prevent this from happening and provide the stakeholders with positive evidence in order to dissuade negative associations of eRA.

Design restrictions:

- The project duration should not exceed 18 months. As discussed in the next chapter implementation of eRA's is planned to take no longer than 18 months.
- The costs for executing the project and maintenance of the new system should not exceed more than $ 200 K on an annual basis. As can be derived from the former ROI analysis, the costs of the eRA project is estimated to costs $ 165 K annually (see Table 12 above).
- The realization of the solution should impact as little as possible the present business processes. The impact on current business processes has been estimated by key stakeholders to be small. Therefore this prerequisite has been met. Hence, the change plan will deal with the issue of implementation in current business practices more extensively.

As can be derived from the argumentation above, eRAs adequately comply with all requirements which have been set by HMC. In addition the designed solution has been evaluated extensively with the manager procurement and the company supervisors and has been redesigned where necessary. Furthermore, the proposed solution has been presented within the bimonthly departmental meeting. During this presentation a discussion took place on the possible impact on working methods, pricing, buyer supplier relationships, etc. The outcomes and content of these discussions were used as input for this chapter.

5.7 *Conclusions*

Goal of this chapter is to supply answers to the questions as stated at the start of this chapter. The first question was: *Which contracts are best suited for eRAing?* This question has been dealt with by providing a decision model and equation to determine the anticipated potential profitability of an eRA. Question 2 was: *What are the design variables of an eRA and when should a particular eRA design be used?* In order to answer this question properly the design variable were first treated in detail, consequently their impact on the behavior of participating vendors, and their suitability under certain

circumstances was discussed. Furthermore, a diagram has been supplied which displays and groups this information. The third question was about how eRAs can be implemented in HMC's current business processes. A 14 step planning and execution procedure was provided to describe the steps which have to be taken in order to prepare, execute and implement eRAs in the current processes. One of the conclusions was that eRAs can be implemented rather easily in the current procurement processes. Fourth an answer is provided to the question: W*hat are the prerequisites when it comes to software implementation*? Concluded was that for HMC implementation and utilization of eRA software is not a problem due to the current hardware and software present in combination with the education level of the employees. On the other hand it is expected that it can be a problem for suppliers of HMC. In order to cope with this, it was advised to prepare and educate those suppliers on the use or eRAs properly. To provide a proper answer to the question *What the most appropriate eRA software package is for HMC*, three different eRA software providers were consulted, and their services in combination with their offers were evaluated. From this analysis it was concluded that eRA software provider Quel is most promising for HMC. As a final step the solution design was evaluation against the requirements as have been set by HMC for potential solution designs. Concluded was that the solution design meets al requirements as set by HMC and therefore is a proper solution to improve TCO at HMC.

6 Change plan

A solution design is not very valuable for a company when it cannot be implemented in it's current business processes and culture. Therefore this chapter deals with the implementation of the solution design in the current business processes by providing a stepwise plan. In addition means to manage buyer supplier relationships when using eRA's are provided in this chapter.

6.1 Implementation within current business processes

As suggested in the former chapter; when it comes to the current business process at HMC, eRAs can be implemented rather easily. The success of eRAs within procurement organizations and new technologies in general depends also for a large degree on how the tool is implemented and embedded in the organization (e.g. Beall et al., 2003; Harink, 2003). Kotter is one of the leading researchers in the field of change management. Kotter (1996) designed a widely utilized eight step change and implementation approach which is also employed and recommended in purchasing practice (Day and Atkinson, 2004). This approach will also be used for implementing eRAs within HMC's procurement organization. The eight steps are described below in accordance with how these have to be executed within HMC (Note that, these steps don't need to be taken in a consecutive manner, but a certain overlap between steps may exist):

1. **Create a sense of urgency***; inspire people to move, make objectives real and relevant.* During the bimonthly departmental meetings communication has to take place on the benefits eRAs can bring for HMC. Also communicate the potential impact of eRAs in relation to EVA (bonus system for all HMC employees).

2. **Build the guiding team**; *get the right people in place with the right emotional commitment, and the right mix of skills and levels.* Beall et al. (2003) reported that both a top down and bottom up implementation approach are effective in implementing eRAs. Where top down implementation results most often in less internal resistance within the whole company, however, no difference exists in the amount of resistance within the procurement department between a top down and bottom up approach. Effective ways to cope with resistance within the buying organization are: Education and implementation of the input of buyers in eRA procedures. Furthermore, Harink (2003) suggest appointing a program manager, when management has decided to implement EP tools. This program manager has to be made responsible for the project of implementing the EP tools.

   The departmental manager is highly motivated and committed to roll-out eRAs within HMC. Furthermore, HMC's top management is also very enthusiastic about e-auctions as a procurement tool for HMC. Therefore the procurement manager in combination with top management can support the top down approach. The departmental manager has to perform tasks concerning e-auctions on a strategic level.

   For executing a bottom up implementation approach a program manger should be appointed. This program manager has to carry out the operational and tactical operations concerning e-auctions. The program manger together with the procurement manager should form the guiding team for this project.

3. **Develop the right vision**; *get the team to establish a simple vision and strategy. Focus on emotional and creative aspects necessary to drive service and efficiency. It has to be simple, straightforward, motivating and actionable.* The following vision statement is suggested for HMC to give expression to this vision: "*Using e-auctions will lead to sustainable TCO reductions*".
4. **Communicate the change vision**; *use as much communication vehicles as possible to expose the vision statement as frequent as possible.* HMC should arrange a specific section on the departmental intranet site where news, gains, etc are reported concerning eRAs. Hence, on this part of the intranet site the change vision also should be communicated. Furthermore, during departmental meetings this vision should also be ventilated, when appropriate.
5. **Empower action**; *remove obstacles, enable constructive feedback and increase support from all stakeholders. Reward and recognize progress and achievements.* HMC has to involve as many people as possible, communicate the essentials, and appeal and respond to people's needs when it comes extra information, training, feedback, changes of procedures (if applicable).
6. **Create short-term wins**; *set aims that are easy to achieve - in bite-size chunks. Manageable numbers of initiatives. Finish current stages before starting new ones.* For this purpose, the implementation of eRAs is divided into three different stages. Where in each stage the focus will be on a different aspect. For an overview of the three stages the author refers to Figure 25. This approach has been designed to create short-term positive outcomes, and mitigate risks as much as possible.

In each stage the focus will be on learning and get experienced with specific aspects of eRAs. In all stages HMC should report on the positive aspects of the eRAs in order to gain internal support for using eRAs. Furthermore, potential elements which can be improved concerning eRAs, lessons learned, etc. should be reported on after an eRA is conducted.

	Stage I	Stage II	Stage III
Screening for contracts for which it is potentially viable to use eRA'	The first eRA's can be held for contracts which are suggested in this thesis. Therefore, in the first stage this aspect is not that important.		
Planning and setting up the event, including inviting and informing suppliers. Getting familiar with eRA software and eRAs as a procurement tool.			
Selecting the qualified suppliers from the long-list of suppliers. Since, the eRA event can attract new vendors it is important to screen those potential new suppliers appropriately.			
Defining proper auctioning rules, and informing vendors. Especially, auction rules determine for a large degree the success of the auction. Defining clear rules and ventilating those rules to the participating vendors.			
Defining the proper eRA design: • Price visibility. • Closing rules. • Award rules. • Lotting Strategy			
Since knock-out criteria, and other monetary and non monetary variables are weighted to calculate the 'end score' of each vendor, simulating the impact of these criteria is of major importance. Therefore one needs to learn how to model and determine what impact these rules will have on the eRA outcome beforehand.			
Adecuately specifying the items which one has planned to eRA.	Easy to specify: Low operational risk associated with these items.		Hard to specify: High operational risk associated with these items.
Managing the impact on trust between buyer and supplier and monitoring what impact the auctions have on the buyer supplier relationships (HMC's reputation as a trade partner,).	Not the main scope of this phase and not that important since suppliers of these goods and services can be replaced quite easily. Furthermore, these goods/services are not crtical for HMC's operations		
Suggested items for this stage:	• Office supplies. • Office cleaning services. • Security services.	• PPE frame agreements. • Small shackles. • Standard tools. • Materials (Piping material, Lifting frames, spreader bars)	• Floating equipment. • Barge cleaning services. • Grillage and sea fastenings. • Anchor wires. • EPIC project related materials and services.
Planning:	First auction before September 2008.	Start: Last quarter of 2008.	Start second quarter of 2009, finalize in the last quarter of 2009.

Figure 25: 3 stage implementation approach

7. **Consolidate and keep up making progress;** *reinvigorating the process with new projects, and change agents. Change systems/processes/elements that don't fit or promote the transformation vision.* HMC should foster and encourage determination and persistence, encourage ongoing progress reporting, and

highlight achieved and future milestones. When necessary change the suggested decision models and process steps with input from all levels (procurement officers, vendors, etc.), in order to optimize procedures, decision making, etc.

8. **Make change stick**; *keep articulating the connections between new behavior, processes and organizational successes*. This phase is the most important to make sure that eRAs won't become obsolete within a short period of time. To overcome this threat HMC should implement eRAs in their remuneration program, KPI's, and targets for the department and for specific employees involved. One could think of:

    - A minimum target set for spend through eRAs and the number of eRAs conducted.
    - A minimum target set for savings realized on process and direct acquisition costs or TCO via eRAs.
    - An increase in the perceived ease of use of the eRA software and support.
    - Increase in percentage of supplier willingness to participate in an eRA.

6.2 Managing buyer supplier relationships

As stated earlier in chapter 2, the buyer-supplier relationship can be at stake when using eRAs improperly. Furthermore, there were some purchasing professionals at the purchasing department who were concerned about the possible impact which eRAs can have on the buyer-supplier relationship and consequential mutual behavior. Therefore, means which obviate these potential negative side effects of eRAs on buyer-supplier relationships will be considered in this section. Negative side effects of harmed buyer-supplier relationships can be deflected in different manners. Suggestions which are made for HMC, to avert possible negative impact on buyer-supplier behavior are based on findings in literature (Beall, et al., 2003; Selnes, 1998; Smart and Harrison, 2003; Schoenherr and Mabert, 2007) and practice (DMCC, DC, Quel):

- Monitoring what impact the auctions have on the buyer supplier relationships (HMC's reputation as a trade partner,). When eRAs are held, HMC should ask for feedback on the eRA process, rules, communication, etc. This information most likely improves the way trade partners perceive the reliability of HMC.
- Communicate the potential benefits for a supplier: Process improvements (reduced cycle time), a chance to retain current business or as a possible mean to expand their current business when a supplier becomes a vendor of HMC as a result of an eRA, an opportunity to gain valuable insights into their competitive standing within their particular market environment. This will increase vendor's willingness to participate in eRAs ex ante. It should be noted that vendor's expectations should not be raised to high in order to prevent a situation wherein the event's outcomes don't meet those expectations.
- Providing timely, sufficient and constructive feedback on all participating suppliers (winners and losers). HMC should try to offer this feedback within a week time, to make sure that the event is still fresh in the memory of the

vendor's and they are able to think back of how things worked out during, upfront, and after the event.

- Guaranteeing suppliers that no deceptive practices will be tolerated (phantom bidders, bidding of unqualified bidders). HMC should guarantee that the eRA event will be executed as ethically as possible and at least as ethical as it would be in a RFx process or via trade negotiations. Communicating eRA rules and supplying feedback about the eRA event afterwards will help to direct the supplier's perception on these aspects in a positive direction.
- Be as transparent as possible when it comes to how the eRA event will be executed. All vendors participating have to have a good understanding of how the awarding process, rules and procedures are, upfront of the event.
- To increase the perceived integrity of the online bidding event, an independent third party could be hired to conduct the eRA event. This decreases the vendor's fear that the buying party may use deceptive practices (phantom bidders, bidding of unqualified bidders) to manipulate the outcomes of the event in favor of the buying party.
- Provide help and assistance during the auction event, enable constant communication when necessary. This will make suppliers more comfortable participating and takes away the anonymity of the online environment.

6.3 Conclusions

This chapter dealt with the implementation of the solution design within the current business processes and organization as it is now. For implementing the solution design within current business processes an 8 step approach is suggested. This method is based on Kotter's (1996) change and implementation approach and adapted to HMC's current situation. Furthermore, since managing buyer-supplier relationships are very important in the business environment HMC operates in and when used inappropriately eRA's can harm these relationships, means to obviate these potential negative side effects of eRAs are brought in.

7 Conclusions and reflection on the project

This chapter deals with the last phase of the regulative cycle as delineated on in chapter 2. First an evaluation of this design study will be supplied. Next the academic and practical implications of this BPSP are delineated on. Then the limitations of this BPSP are described, and finally directions for future research are discussed.

7.1 Conclusions

During this study first answers were found to the sub questions in order to be able to answer the main question of this study which is: *"What new purchasing methods can decrease Total Cost of Ownership within Heerema Marine Contractors"*. A TCO analysis has been conducted to identify the effect purchasing activities have on TCO for procured items per group. This study revealed the most important cost drivers, processes, and methods used to acquire materials, equipment, manpower, and services within each group. It was concluded that for all groups, except the vessel purchasing group counts that direct acquisition costs account for the largest portion of costs. For the items purchased by the vessel purchasing group, the administrative costs account for the majority of TCO (see Table 13).

Cost drivers / Divisions	Spend (in $ Mln)	Transportation	Direct purchasing costs	Quality and reputation	Administration	Inventory holding costs
Floating equipment	$ 130	+	++	-+	-	N.A.
Vessel purchasing	$ 45	-+	-	-	++	-
Non vessel purchasing	$ 175	-	++	-	-	-
Subcontracting equipment, services	$ 315	-	++	++	+	N.A.
Subcontracting fabrication	$ 10	+	+	-+	-	N.A.
	$ 675					

Legenda:
+ Much impact
++ Very much impact
- Little impact
-- Very little impact
-+ No or very little impact
N.A. Not Applicable for this division

Table 13: Overview of dominant cost drivers per group

Secondly, a focused study has been conducted which resulted in additional evidence to cross validate causes and effects of the identified problems within the vessel purchasing group. As a result of this focused study in combination with the study on a departmental level, directions for change were elaborated on a conceptual level. These conceptual solution designs were evaluated on the basis of the requirements as set by HMC and expected ROI of each solution. The analysis revealed that the conceptual solution: eRAs was most promising with a ROI of 7.4. In a solution design the conceptual design of eRAs was further elaborated. Moreover, a change plan has been written to implement and embed eRAs within HMC's current business processes.

7.2 Contribution to academic literature and practice

Much research has been conducted and literature has been written on the subjects TCO, and eRAs. This study's empirical evidence and analysis contributes to these bodies of knowledge by using a TCO approach for determining which areas and groups one should focus on given the procurement groups' practices and their effect on TCO.

It has been found that a TCO approach gains many insights in the most promising direction for improving business processes and new tools to use at HMC as an offshore marine contractor. Furthermore, evidence has been provided that eRA's can be a valuable procurement tool in the dredging and marine contracting industry as a result of interviews held at DMCC and DC. In addition indications have been provided that e-reversed auctioning could also be of help in reducing TCO at HMC. Results of both tools in these specific industry settings (dredging and marine contracting industry) haven't been reported on, until now.

Next to a contribution to academic literature, practical contributions have been made. Two decision models have been suggested which are based on academic literature and empirical findings. The first supports the decision making process of determining whether it is appropriate to eRA an item or not. The second model supports decision making on the most appropriate eRA design. In addition a stage-gate approach has been advised to implement and learn to work with the advised eRA tool. Goal is to mitigate risks with the help of this stage-gate approach.

7.3 Limitations

Information on procurement processes taking place at the vessels (specifying the goods, sending requisitions, expediting and evaluation of the goods) has been retrieved by sending questionnaires. The same counts for the logistics department located in Fourchon (Louisiana, USA). This decision has been made due to the (remote) offshore locations where the vessels operate, time zone differences, etc. Due to this way of data and information collecting, information richness is most likely lower compared to a situation where information is retrieved via semi-structured interviews. Moreover, a drawback of questionnaires can be the use of suggestive and/or subjective questioning, which consequently can direct the answers in a certain direction. Hence, off course in the preparation phase this has been taken into account as much as possible to overcome this drawback as much as possible.

Furthermore, the information on processes would be even more reliable when these processes were monitored in a sequential stage. In this manner one could verify the findings: Time and effort spend, per task, stage function, and type, and relationship of causes which retard the procurement process in those different stages.

7.4 Future research

In general there is not much research conducted on purchasing practices in the specific industry setting: marine offshore contracting. Due to the specific market conditions (low number of 'qualified' suppliers) and cost structures (costs of equipment makes up a large portion of overall costs) this industry is a very specific and interesting one to explore more extensively. Especially, the buyer-supplier relationships within the offshore marine construction industry are perceived to be very important when conducting business.

Furthermore, comparing buyer-supplier relationships within the marine contracting industry with other industries (like: consumer electronic, aerospace, industries etc.) could supply valuable insights.

The suggested decision models for HMC are based on both literature and findings from practice. The actual implementation and reflection on the implementation of the tool are out of scope of this study. Studies that focus on the outcomes of the implementation, and results from the actual use of the suggested eRA tools in this industry setting, will potentially enlarge the insights on the suggested decision models, and the use of these in this specific industry setting.

Since both models haven't been tested yet, a rewarding avenue for future research could also be determining whether the models are designed appropriately, and applicable in other industry settings. Output from such a study could lead to support for the model or evidence that the model needs to be adjusted. In any case such a study would lead to an even more valuable model, and for which is there is evidence that it also works in other settings.

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Appendix I: List of abbreviations

Abbreviation	In Full:	Description
BOM	Bill of Materials	Bill of materials (BOM) is the term used to describe the "parts list" of components needed to complete a saleable end-item (Wikipedia).
BP		BP is a company which main operations are in the field of exploration, production, transportation, and refinement of natural resources, mainly gas and oil). BP is the result of a merger of the former British Petroleum, Amoco, Atlantic Richfield Company (ARCO), Castrol en Aral.
BPSP	Business Problem Solving Project	A project aimed at solving a business problem in a real-life context.
EP	E-procurement	Internet technology supported procurement
EPIC (contract)	Engineering, Procurement, Installation & Commissioning (contract)	
ERP	Enterprise Resource Planning systems	Enterprise resource planning (ERP) systems attempt to integrate several data sources and processes of an organization into a unified system (Wikipedia)
EM	Equipment Management Department	
HMC	Heerema Marine Contractors	The focal company of this BPSP
	Maverick Buying	"Maverick" buying refers to the purchase of goods or services without using the firm's formally defined processes and authorized vendors (Van Weele, 2005).
eRA('s).	Internet Reversed Auction(s)	
KPI	Key Performance Indicator	A Key Performance Indicator is a critical measurement used for gauging the

		performance of essential tasks, operations, or processes. A KPI will usually unambiguously reveal conditions or performance that is outside the norm and that signals a need for managerial intervention.
MSA	Master Service Agreement	A Master Service Agreement defines the scope of services, including a description of the components, and an agreement on how the components will be managed and serviced throughout the lifetime of the contract.
MRO	Maintenance, Repair, Operations or Maintenance, Repair, Overhaul items	Routine purchases such as office supplies, travel services, or computers needed to run a business but not central to the business output.
MRP	Material Requirements Planning	Material Requirements Planning (MRP) is software based production planning and inventory control system used to manage manufacturing processes (Wikipedia).
OEMs	Original Equipment Manufacturer	The original manufacturer of a component for a product or a complete product, which may be resold by another company (Wikipedia).
OPS	Operations Department	
PO	Purchase Order	An order for purchase. Most often executed via the SAP system.
PPE	Personal Protective Equipment	Personal Protective Equipment (PPE) refers to protective clothing, helmets, goggles, or other gear designed to protect the wearer's body or clothing from injury by electrical hazards, heat, chemicals, and infection, for job-related occupational safety and health purposes, and in sports, martial arts, combat, etc. (Wikipedia).
PR	Purchase Requisition	An internal request for purchasing a specific item(s)
	Purchasing	Obtaining from external sources goods, services, capabilities, and knowledge in the right quantity, from the right source, for delivery at the right time and in the right place, with the right service and at

		the right price. This in order to run, manage, and maintain the company's primairy and support activities (Van Weele, 2005).
	Procurement	Procurement denotes the process of purchasing.
RFx		RFx is a general term which can refer to: Request For Information (RFI), Request For Comment (RFC), Request For Tender (RFT), Request For Proposal (RFP), Request For Quotation (RFQ).
ROV	Remote Operating Vessel	Remote Operating Vessel. Most often ROV's are subsurface vessels for inspection or operations below surface in environments where it is not feasible or to dangerous to put divers into action.
	Spend Management	All activities related to the capturing, analysing, reporting of spend data, and the periodic reporting of predictions, control measures in order to optimize the spend.
	(Business) Strategy	A strategy is a long term plan of action designed to achieve a particular goal. Business strategy, the art and science of enabling an organization to achieve its objective(s) (Wikipedia).
	Strategic purchasing	The process of planning, implementing, evaluating, and controlling strategic, and operational purchasing decisions for directing all activities of the purchasing function toward opportunities consistent with the firm's capabilities to achieve long-term goals (Carr and Smeltzer, 1997, p. 201)
SLA	Service Level Agreement	Service Level Agreement is that part of a service contract where the level of service is formally defined. In practice, the term SLA is sometimes used to refer to the contracted delivery time (of the service) or performance (Wikipedia).
TCO	Total Cost of Ownership	All costs associated with the acquisition, use, maintenance, and waste of a good or service
VAR	[edit] Value Added Reseller	A value-added reseller (VAR) is a company that adds some feature(s) to an existing product(s), then resells it

		(usually to end-users) as an integrated product or complete "turn-key" solution (Wikipedia).

Table 14: List of abbreviations

Appendix II: Project approach

	Project steps:	Project phase:
1.	How is the current procurement process organized?	Orientation
2.	Determine the dominant cost drivers per group within the procurement department	Orientation
3.	Determine which group to focus on.	Analysis and diagnosis
4.	OPTIONAL: Explore what experience similar companies have with e-procurement tools, and what experience they have with those tools and what the critical success factors were/are in decreasing TCO.	Analysis and diagnosis
5.	Desk study on means which can increase efficiency in the purchasing processes (and reduce direct and/or indirect purchasing costs).	Analysis and diagnosis
6.	What changes can be initiated to decrease relevant costs within HMC's procurement organization.	Diagnosis
7.	Determine which changes probably have the largest possitive effect, and which will be further described into a change plan. Within this step, a presentation is incorporated, on the basis of this presentation the most promising direction for change are determined.	Plan of action
8.	Design a change plan	Plan of action
9.	OPTIONAL: Execute a number of purchases with the changes in place.	Intervention
10.	OPTIONAL: Gauge the effect of those change(s).	Evaluation

Table 15: Questions and phases

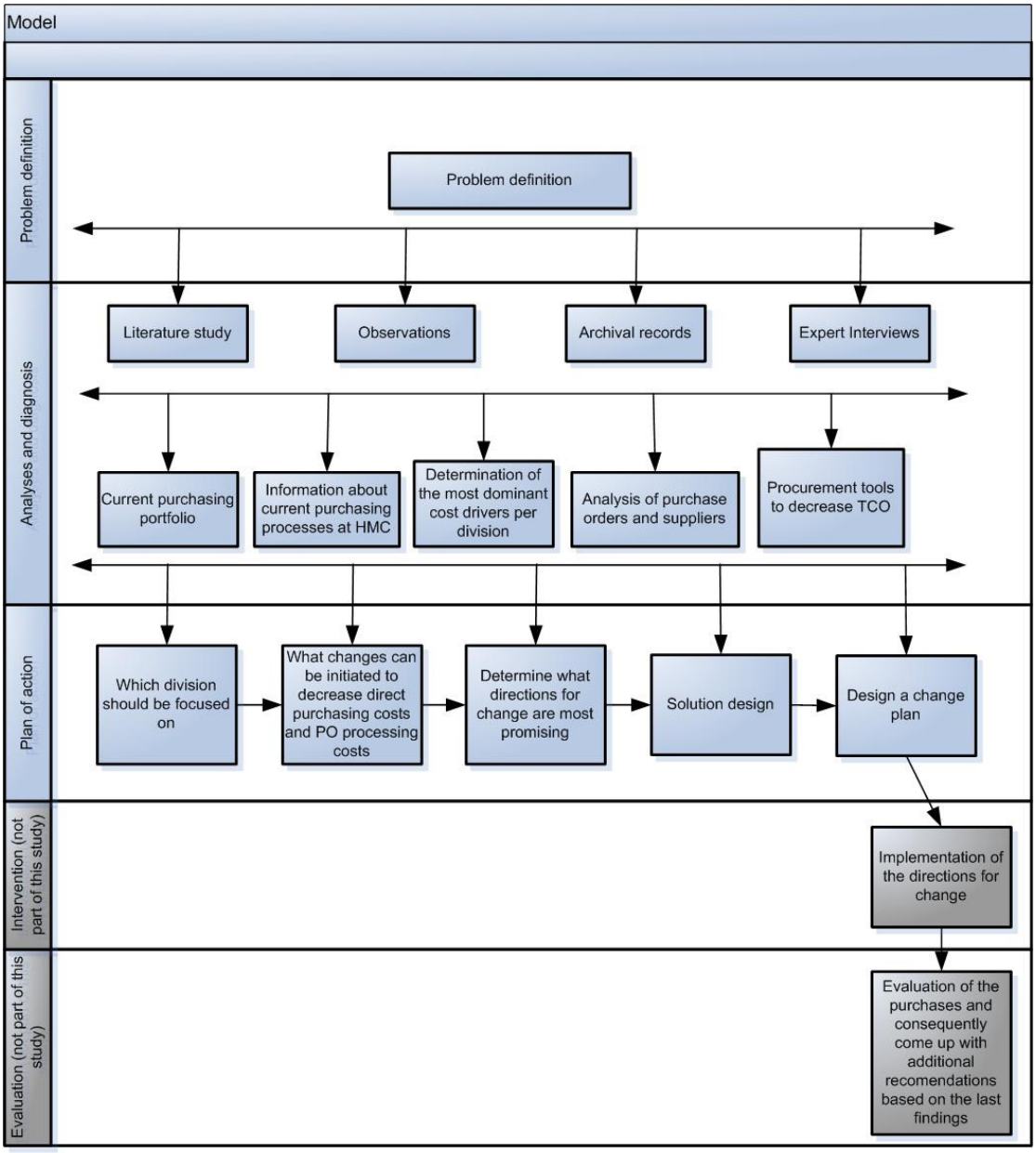

Figure 26: Study model

Source of Evidence	Strengths	Weaknesses
Documentation	• Stable - repeated review • Unobtrusive - exist prior to case study • Exact - names etc. • Broad coverage - extended time span	• Retrievability - difficult • Biased selectivity • Reporting bias - reflects author bias • Access - may be blocked
Archival Records	• Same as above • Precise and quantitative	• Same as above • Privacy might inhibit access
Interviews	• Targeted - focuses on case study topic • Insightful - provides perceived causal inferences	• Bias due to poor questions • Response bias • Incomplete recollection • Reflexivity - interviewee expresses what interviewer wants to hear
Direct Observation	• Reality - covers events in real time • Contextual - covers event context	• Time-consuming • Selectivity - might miss facts • Reflexivity - observer's presence might cause change • Cost - observers need time
Participant Observation	• Same as above • Insightful into interpersonal behavior	• Same as above • Bias due to investigator's actions
Physical Artifacts	• Insightful into cultural features • Insightful into technical operations	• Selectivity • Availability

Table 16: Case study research methodologies (source: Yin, 1994, p. 80)

1. Data triangulation,	This entails gathering data through several sampling strategies, so that slices of data at different times and social situations, as well as on a variety of people, are gathered.
2. Investigator triangulation,	This mode refers to the use of more than one researcher in the field to gather and interpret data.
3. Theoretical triangulation,	This type refers to the use of more than one theoretical position in interpreting data.
4. **Methodological triangulation**,	Refers to the use of more than one method for gathering data.

Table 17: Types of triangulation

Appendix III: HMC's Procurement data

Range from	$ -	$ 500	$ 1,000	$ 10,000	$ 100,000	$ 1,000,000	ALL
Range to	$ 500	$ 1,000	$ 10,000	$ 100,000	$ 1,000,000	$ 100,000,000	ALL
2006							
# order lines (line valu							
% of total							
# P.O.'s							
% of total (P.O. value)							
Number of vendors (P.							
Total value							
2007							
# order lines (line valu							
% of total							
# P.O.'s							
% of total (P.O. value)							
Number of vendors (P.							
Total value							

Table 18: PO's and PO value for all PO's within HMC

Fabrication

	2005	2006	2007
EU region in euro's			
Yearly av. Dollar/Euro exchange rate (source: www.federalreserve.gov)			
EU region in USD			
# P.O.'s EU regon			
Average P.O. value EU region			
US in USD			
# P.O.'s US			
Average P.O. value US			
Total			

Table 19: Annual figures subcontracting fabrication

Appendix IV: Questionnaire and support letter

Dear colleague(s),

For my graduation project I am investigating what could be improved in the procurement process in terms of process as well as direct acquisition costs.

In order to gain insight in the costs associated with the process of acquiring goods, I would like to ask you to provide me some information on these processes. I would be happy when you would share your information with my by filling in the attached questionnaire.

Kind regards,

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Website: www.heerema.com

Questionnaire

1. What is the time needed to execute the described task if applicable in your position (average on a weekly basis). Below you find a description of the different steps in the process of acquiring goods (in case the need for certain items is identified on the vessels). Please fill in the average number of hours spend per process step on weekly basis in the table below (only if applicable for your current job function):

Determine specifications:
Specify the products needed. Make a requisition with an adequate description of the products and acquire the necessary approvals.
Supplier selection:
Assign requisition to the appropriate procurement officer, create a request for quotation, and select the most suitable suppliers.
Contracting:
Sending request for quotation, receive bids, evaluation of bids and determine most promising bid and vendor.
Ordering:
Create and sign of order.
Expediting and evaluation:
Receive, inspect, ship received goods to vessels. Receive, and inspect goods on board.
Follow up and evaluation:
Vendor evaluation
Payment:
Receive, check invoice, and match invoice with PO goods received, resolves possible issues, and pay invoice

Determine specifications	Supplier selection	Contracting	Ordering	Expediting and evaluation	Follow up and evaluation	Payment	Total

2. What factors/situations/etc. impact the time needed to execute these tasks, and what additional time does it take extra to execute these tasks in:
   a. .....
   .....
   .....
   b. .....
   .....
   .....
   c. .....
   .....
   .....

3. When one considers the amount of time needed to execute the above stated tasks. Are there vendors which require above average time?

   .....

4. Who are these vendors?

   .....
   .....
   .....
   .....

Appendix V: Vessel purchasing group

		Specification	Supplier selection	Contracting	Order	Expediting and monitoring	Follow-up and evaluation	Payment
Balder	Store keeper	x				x		
	Store keeper 2	x				x		
	Chief Store keeper	x	x			x		
	Captain	x						
	Super Intendent	x						
	Chief Engineer	x						
Hermod	Store keeper	x				x		
	Chief Store keeper	x				x		
	Captain	x						
	Super Intendent	x						
	Chief Engineer	x						
Thialf	Store keeper	x	x			x		
	Chief Store keeper	x	x			x		
	Captain	x						
	Super Intendent	x						
	Chief Engineer	x						
	Budget holder(s) office	x						
	Secretary	x						
	Man. Procurement		x	x	x		x	
	Buyer(s) Balder		x	x	x		x	
	Buyer(s) Hermod		x	x	x		x	
	Buyer(s) Thialf		x	x	x		x	
	Buyer(s) Fourchon		x	x	x		x	
	Logistic store keeper (Vlissingen)					x		
	Logistic store keeper (Fourchon)					x		
	Finance (Invoice audit controller)							x

Table 20: Interviewed persons per process step

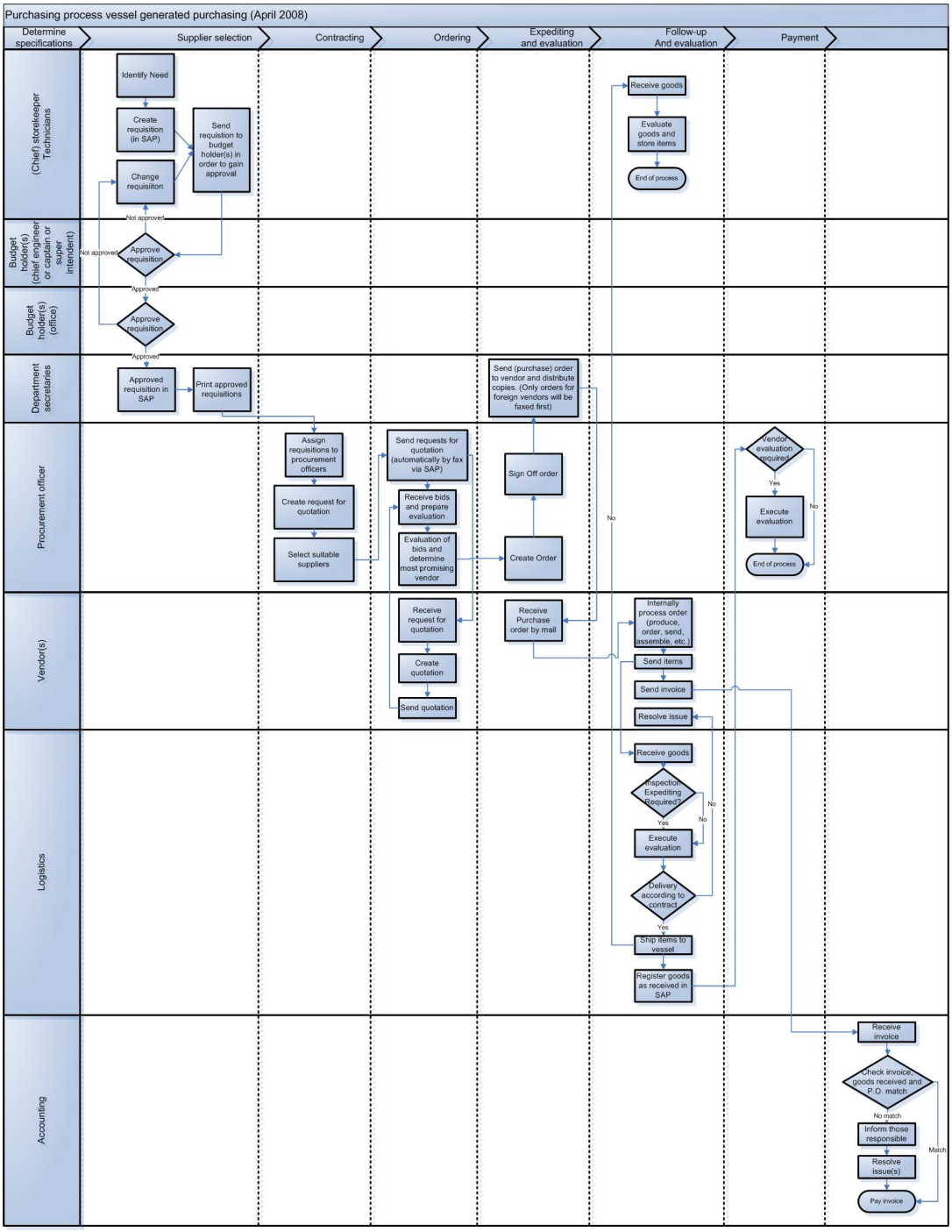


Figure 27: Purchasing process vessel purchasing

Determine specifications	Supplier selection	Contracting	Ordering	Expediting and evaluation	Follow up and evaluation	Payment	Total
$64	$39	$47	$12	$67	$13	$18	$259
25%	15%	18%	5%	26%	5%	7%	100%

Table 21: Process costs per process step in the procurement process

		Determine specification			Supplier selection			Contracting			Order			Expediting and monitoring			Follow-up and evaluation			Payment			Totals			
		Hours per week	Costs per week	% of total costs per week	Hours per week	Costs per week	% of total costs per week	Hours per week	Costs per week	% of total costs per week	Hours per week	Costs per week	% of total costs per week	Hours per week	Costs per week	% of total costs per week	Hours per week	Costs per week	% of total costs per week	Hours per week	Costs per week	% of total costs per week	Total hours per job function per week	Total costs per job function per week	Hours/year per FTE	Year expenses per FTE
Balder	Store keep	7	€ 198,39	1,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	16	€ 453,46	2,2%		€ -	0,0%		€ -	0,0%	***23***	***$ 652***	$ 2.760	$ 78.222
	Store keep	7	€ 198,39	1,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	16	€ 453,46	2,2%		€ -	0,0%		€ -	0,0%	***23***	***$ 652***	$ 2.760	$ 78.222
	Chief Store	20	€ 769,83	3,7%	3	€ 115,47	0,6%		€ -	0,0%		€ -	0,0%	17	€ 654,36	3,2%		€ -	0,0%		€ -	0,0%	***40***	***$ 1.540***	$ 2.760	$ 106.237
	Captain	2	€ 129,80	0,6%		€ -	0,0%		€ -	0,0%		€ -	0,0%	0,5	€ 32,45	0,2%		€ -	0,0%		€ -	0,0%	***3***	***$ 162***	$ 2.760	$ 179.124
	Super Inte	1	€ 72,45	0,3%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	***1***	***$ 72***	$ 2.760	$ 199.959
	Chief Engi	1,5	€ 97,35	0,5%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	***2***	***$ 97***	$ 2.760	$ 179.124
Hermod	Store keep	7	€ 198,39	1,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	16	€ 453,46	2,2%		€ -	0,0%		€ -	0,0%	***23***	***$ 652***	$ 2.760	$ 78.222
	Chief Store	16	€ 615,87	3,0%	2	€ 76,98	0,4%		€ -	0,0%		€ -	0,0%	20	€ 769,83	3,7%		€ -	0,0%		€ -	0,0%	***38***	***$ 1.463***	$ 2.760	$ 106.237
	Captain	2	€ 129,80	0,6%		€ -	0,0%		€ -	0,0%		€ -	0,0%	0,5	€ 32,45	0,2%		€ -	0,0%		€ -	0,0%	***3***	***$ 162***	$ 2.760	$ 179.124
	Super Inte	1	€ 72,45	0,3%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	***1***	***$ 72***	$ 2.760	$ 199.959
	Chief Engi	1,5	€ 97,35	0,5%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	***2***	***$ 97***	$ 2.760	$ 179.124
Thialf	Store keep	18	€ 510,15	2,5%	6	€ 170,05	0,8%		€ -	0,0%		€ -	0,0%	16	€ 453,46	2,2%		€ -	0,0%		€ -	0,0%	***40***	***$ 1.134***	$ 2.760	$ 78.222
	Chief Store	20	€ 769,83	3,7%	3	€ 115,47	0,6%		€ -	0,0%		€ -	0,0%	12	€ 461,90	2,2%		€ -	0,0%		€ -	0,0%	***35***	***$ 1.347***	$ 2.760	$ 106.237
	Captain	2	€ 129,80	0,6%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	***2***	***$ 130***	$ 2.760	$ 179.124
	Super Inte	1	€ 72,45	0,3%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	***1***	***$ 72***	$ 2.760	$ 199.959
	Chief Engi	1,5	€ 97,35	0,5%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	***2***	***$ 97***	$ 2.760	$ 179.124
	Budget hol	6	€ 378,14	1,8%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	***6***	***$ 378***	$ 1.767	$ 111.361
	Secretary	20	€ 596,29	2,9%		€ -	0,0%		€ -	0,0%	5	€ 149,07	0,7%		€ -	0,0%		€ -	0,0%		€ -	0,0%	***25***	***$ 745***	$ 1.767	$ 52.682
	Man. Procurement		€ -	0,0%	1	€ 81,98	0,4%	1	€ 81,98	0,4%	2	€ 163,96	0,8%		€ -	0,0%	6	€ 491,89	2,4%		€ -	0,0%	***10***	***$ 820***	$ 1.767	$ 144.863
	Buyer Balder		€ -	0,0%	15	€ 787,78	3,8%	17	€ 892,82	4,3%	4	€ 210,08	1,0%		€ -	0,0%	2	€ 105,04	0,5%		€ -	0,0%	***38***	***$ 1.996***	$ 1.767	$ 92.801
	Buyer Hermod		€ -	0,0%	11	€ 577,71	2,8%	22	€ 1.155,42	5,6%	3	€ 157,56	0,8%		€ -	0,0%	3	€ 157,56	0,8%		€ -	0,0%	***39***	***$ 2.048***	$ 1.767	$ 92.801
	Buyer Thialf		€ -	0,0%	15	€ 787,78	3,8%	19	€ 997,86	4,8%	2	€ 105,04	0,5%		€ -	0,0%	2	€ 105,04	0,5%		€ -	0,0%	***38***	***$ 1.996***	$ 1.767	$ 92.801
	Buyer Fourchon		€ -	0,0%	7	€ 367,64	1,8%	12	€ 630,23	3,0%	3	€ 157,56	0,8%		€ -	0,0%	3	€ 157,56	0,8%		€ -	0,0%	***25***	***$ 1.313***	$ 1.767	$ 92.802
	Logistic store keeper (V		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	24	€ 1.105,37	5,3%		€ -	0,0%		€ -	0,0%	***24***	***$ 1.105***	$ 1.767	$ 81.383
	Logistic store keeper (B		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	10	€ 460,57	2,2%		€ -	0,0%		€ -	0,0%	***10***	***$ 461***	$ 1.767	$ 81.383
	Finance (invoice audit (		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%		€ -	0,0%	40	€ 1.445,64	7,0%	***40***	***$ 1.446***	$ 1.767	$ 63.861

Table 22: Process costs per process step per job function in the procurement process

Job function	Description of the problem:	Cause:
Procurement officer(s)	When quotations are received from vendors (which received an RFQ) the most favorable quotation and vendor will be selected. Next from the PR/RFQ in SAP a PO will be created. In this process the prices from the quotation need to be filled in manually in SAP. In case the RFQ has many (for example up to 60 or more) line items this is a time consuming and thus costly undertaking.	Number of line items per PR, number of PR's. Not digitally receiving and processing of quotations.
Finance	Quotations are sending by vendors to HMC with items grouped to a single line item. Due to the limited flexibility in the SAP system the purchase request (which is freezed after the purchase request has been approved) doesn't match the PO and the PO doesn't match with the invoice.	Vendors group certain items in a package or single item (instead of separately quoting all parts/items). Little flexibility in the SAP system to adjust orders to the format of vendors. Little technical knowledge at the finance department.
Logistics	Vendors deliver items at the incorrect address. (New) Vendors send item(s) to the invoice address instead of the delivery address. This occurs more frequently with new vendors than with vendors which are used on a more regular basis.	Vendors mix up/interchange the delivery and invoice address. Most often this occurs with new vendors.
Logistics and procurement	Late delivery of items at one of the yards. Those items then need to be shipped by air instead of by vessel.	Vendors have productions problems. Vendors do not communicate delays.
Procurement officer(s), Storekeepers, Technicians	Late delivery of items,	Miscellaneous causes, internal as well external
Logistics	Delivery of parcels on incorrect pallets which are	Vendors do not read the information on the PO properly.

	not certified as bug free or not strong enough, etc. This occurs more frequently with new vendors then with vendors which are used on a more regular basis, and are not used to export goods abroad the EU.	Vendors are not aware of the fact that pallets which will be shipped abroad need to be certified.
Logistics	Vendors receive sometimes multiple orders a week which have to be shipped to one of the crane vessels. Fourchon or Vlissingen where vendors deliver their items is not the end station for these goods; the parcels have to be shipped to one of the vessels. Therefore each PO or at least orders for each vessel has to be packed separately, otherwise the logistics storekeeper has to repackage each parcel/pallet.	Most often the cause lies in the fact that the (new) vendor is not aware of HMC's internal supply chain
Procurement officer(s),	Vendor(s) did not receive the purchase order which results in no delivery which only gets noticed at the moment the items are really needed,	The PO got stuck in the mail company's supply chain. The hardcopy PO has not been sent via mail??? Usually low value PO's are not sent double to vendors so that they can send a PO acceptance back.
Procurement officer(s),	Not receiving bids from vendors,	This can be due to a malfunctioning (automated) fax system or vendors that are not willing to quote/deliver. Item description and number do not match. Or description and item code do not provide enough information to base a quotation on.
Procurement officer(s), Storekeepers, Technicians	Extra time needed to specify items by procurement officers. The vessel has to be consulted to gain extra information about specifications, drawings,	Items are not well specified or item code does not match with specifications. The regular specifications do not provide enough information.

	pictures, etc.	
Procurement officer(s), Storekeepers, Technicians	Receiving incorrect goods from suppliers. This is only identified at the moment the vessel receives the goods.	The items are not well specified. The vendor interprets the item description incorrect. An error occurred at the vendor when processing the PO Goods received at the logistic hubs are seldom inspected and checked whether they match with the original purchase request.
Procurement officer(s),	Not or not properly sending RFQ's,	Errors in the automated fax system
Miscellaneous	Invoice does not match the PO on a line item level which causes the accounting officer to act on this discrepancy.	Miscellaneous causes, internal as well as external
Miscellaneous	Invoices for goods which are not received, none, or unproved purchase requests/orders	Miscellaneous causes, internal as well as external
Procurement officer(s), Secretary	Extra costs associated with introducing new suppliers (administratively processing, auditing, managing),	Miscellaneous causes, internal as well as external
Procurement officer(s),	No or little history about procurement history of items. No price reference, no information about potential vendors for a certain item.	3 instead of 1 MEM database
Procurement officer(s),	Procurement items are not grouped into categories in the SAP (EPR) system or in the MEM system.	Lack of consistency in the ERP and MEM system.

Table 23: Issues which cause the procurement process to retard

Appendix VI: New Built Vessel

NA OPLEVERING IS HET VAARTUIG GROTER DAN DE THIALF

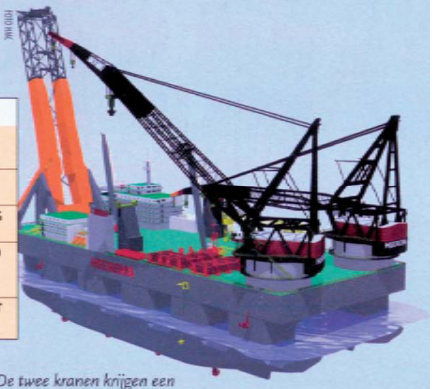
VIERDE KRAANSCHIP VOOR HEEREMA

Het Nederlandse bedrijf Heerema Marine Contractors investeert 740 miljoen euro in de bouw van een nieuw kraanschip. Het schip, dat ook leidingen op de bodem van de zee kan leggen, is bestemd voor de installatie van productieplatformen. Heerema Marine Contractors heeft drie kraanschepen in dienst. Deels door de hoge olieprijs heeft het offshoreconstructiebedrijf veel werk, zodat een vierde schip noodzakelijk is. Het vaartuig, dat in 2010 klaar moet zijn, zal de prestaties en afmetingen van de andere drie kraanschepen overtreffen. De Thialf, naar hefvermogen op dit moment het grootste schip ter wereld, hijst met twee kranen maximaal 14 200 ton. Het nieuwe kraanschip krijgt een hefcapaciteit van 15 000 ton en zal bij oplevering de leidende positie van de Thialf overnemen. Naast de kranen krijgt het vaartuig een toren voor het leggen van leidingen tot een diepte van 3500 m. De maximumsnelheid van het te bouwen schip bedraagt twintig knopen (37 km/h), terwijl de Thialf zeven knopen (13 km/h) haalt. Heerema Marine Contractors wil het nieuwe schip ook in het noordpoolgebied kunnen inzetten. Daarom houdt het ontwerp rekening met werk bij vrieskou.

www.heerema.com

KENGETALLEN

LENGTE	220 m
BREEDTE	88 m
MAX.DIEPGANG	44 m
MAX.SNELHEID	20 kn 37 km/h
HEFCAPACITEIT	15 000 ton



De twee kranen krijgen een gezamenlijke hefcapaciteit van 15 000 ton.

Source: 'De Ingenieur' 2007

Heerema's $1 Bn vessel full steam ahead

Heerema Marine Contractor's plans to sink US $1 Bn into the building of a new deepwater construction vessel (*see DI, 11 December 2006, page3)* are proceeding full steam ahead, with the Dutch-based contractor saying it will enter the market in 2010.

The new vessel, designed inhouse by HMC, will have a maximum speed of 20 knots, up to four times the speed of its current deepwater construction vessels. This will help to dramatically cut transit time between projects and provide our clients with more productivity in a broader range of geographic areas.

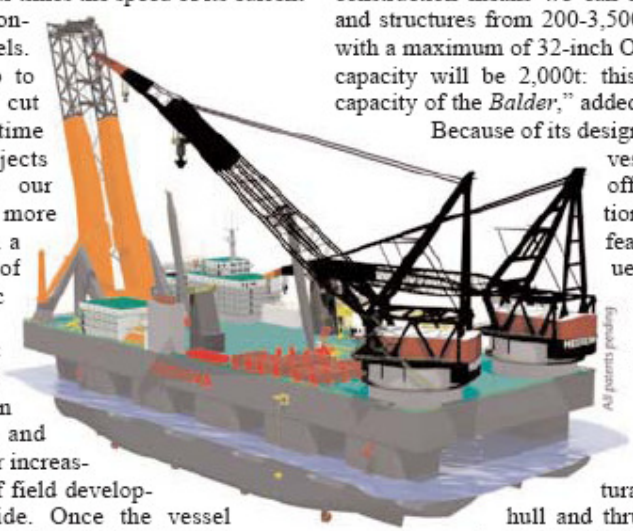
HMC says it will enable it to "operate in remote areas and ultra deepwater increasing the pace of field development worldwide. Once the vessel enters the market in 2010, it will secure construction capacity for at least another three decades".

The new vessel will be 220m long, 88m wide and 44m in depth, with facilities for 550 people, upgradeable to 750 people. Payload is 25,000 tonnes and the power generation capacity will be of 75 MW. The Dynamic Positioning Station keeping system will be of NMD Class III.

"The dual crane capacity of 15,000t will enable us to continue installing the largest and heaviest fixed and floating structures to date. The new J-Lay tower and deepwater lowering construction means we can install pipelines and structures from 200-3,500m water depth with a maximum of 32-inch O.D. The tension capacity will be 2,000t: this is double the capacity of the *Balder*," added the company.

Because of its design and speed, the vessel will make offshore construction in the Arctic feasible, it continued. The placement of the cranes, the J-Lay tower and other installation equipment, as well as the structural quality of the hull and thrusters, are well suited for the Arctic.

Next steps - to be expected this summer - will be the long-lead ordering of key components, such as the cranes and J-Lay Tower. Options are currently being discussed with possible suppliers.



Source: Deepwater International 14 May 2007

Appendix VII: eRA software and service suppliers

Prices visible for all participating vendors			
Ranking of each participant visible for all participating vendors			
Using soft-issues			
Using knock-out criteria			
Possibility to conduct a sensitivity analysis upfront with the auction rules in place			
Real-life assistence from software vendor			
Instruction of participating vendors by software supplier			
Question and answer support built in the tool			
Vendor's locations			
Costs software fee (annual)			
Additional costs per auction			
Planned number of auctions per year (after the system has been implemented after 2 years)			
Total costs for the software package (expected)			
Contact person:			
Telephone number:			
E-mail:			

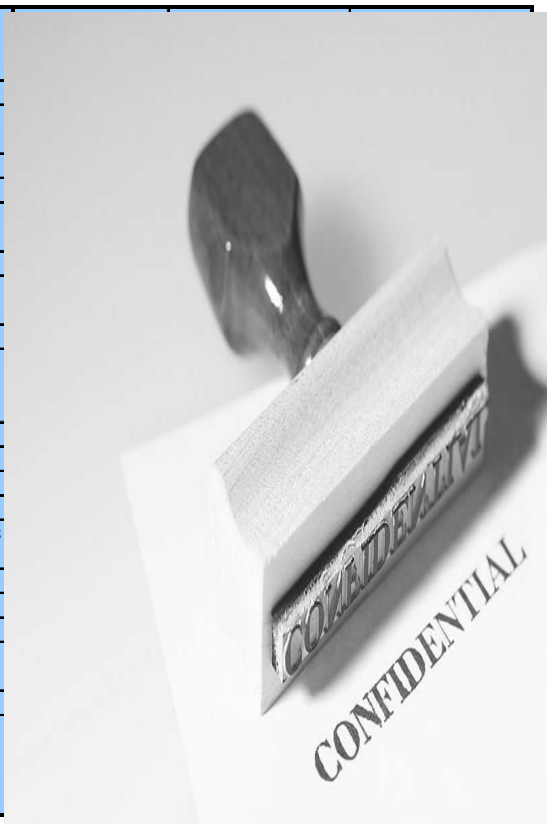


Table 24: e-reversed auctioning software providers and their quotations

Appendix VII: HMC's supplier code of conduct

Supplier Code of Conduct

Heerema Marine Contractors takes seriously our commitment to social responsibility, safety, environmental leadership and ethical business practices ensuring that the decisions we make today are also the right decisions for the future. This commitment is at the heart of how we do business. We expect our Suppliers of goods and services to adhere to these fundamental values and apply them to how they do business here and around the world.

Stefan Hase
Heerema Marine Contractor's Chief Financial Officer (CFO)

Our Purpose

At Heerema Marine Contractor, our purpose is to create superior and sustainable value for our customers, employees, communities and investors by being and be recognized as the best offshore construction contractor in the world.

Our Values

- **QESH**—A commitment to Quality, environmental responsibility, safety and health, and our communities.
- **Integrity**—Ethically and honestly doing what we say we will do.
- **Respect for the Individual**—Embracing diversity and inclusion, enhanced by openness, sharing, trust, teamwork and involvement.
- **High Performance**—Achieving superior business results and stretching our capabilities.
- **Win-Win Relationships**—Having relationships which focus on the creation of value for all parties.
- **Initiative**—Having the courage, creativity and discipline to lead change and shape the future.

Sustainability

Sustainability is a balanced approach to decision making that takes into consideration the needs of all our stakeholders. Below are the five key aspects of Sustainability at Heerema Marine Contractors .

- **Social Responsibility**—Improving the quality of life in the communities we serve.
- **Economic Vitality**—Keeping energy costs affordable, working to create jobs that strengthen our economy and creating value for our investors.

- **Environmental Stewardship**—Conserving natural resources, reducing the environmental impact of our operations, increasing energy efficiency, and expanding our use of alternative energy sources.
- **Workplace Quality**—Creating a safe, healthy, and inclusive work environment that offers opportunities for career growth and development.
- **Ethics and Governance**—Maintaining high standards of integrity and transparency in all our business practices and reporting.

Expectations of Business Conduct

Safety

Safety is always our first consideration. It is not optional. Suppliers must apply safe work practices (including regulatory and contract specific requirements) to all activities and exercise good judgment in work decisions. Suppliers performing work on our property or on our behalf must instill safety in every aspect of their work processes and in the attitude and behavior of all their employees.

Environmental

Heerema Marine Contractors aspires to be an industry leader in protecting our environment. We are committed to meet or surpass all applicable regulatory requirements and seek ways to enhance the communities we serve. Suppliers must comply with all applicable environmental laws and regulations and conduct their operations in an environmentally responsible manner.

Company Resources

Company resources include property, assets, intellectual property and confidential information. Suppliers are responsible to safeguard Heerema Marine Contractors resources utilized in the course of performing work. Heerema Marine Contractors resources must only be used for legitimate business purposes to advance the interests of it's client. The personal use of Heerema Marine Contractors resources without permission is prohibited. The intellectual property rights of Heerema Marine Contractors and those of third parties must be honored at all times. Confidential information can only be shared within your company on a need to know basis. Sharing confidential information with third parties is not allowed without express permission. Buying or selling securities based upon material, nonpublic information, as well as sharing nonpublic information, could result in serious civil and criminal penalties.

Brand and Trademarks

We expect Suppliers who interact with our customers to conduct themselves at all times in ways that reinforce and strengthen the Heerema Marine Contractors brand. Use of Heerema Marine Contractors' brand is not permitted without express written permission which is rarely granted.

Accounting and Business Records

All financial books, records and accounts must accurately reflect the underlying activity and conform both to generally accepted accounting principles and a system of internal controls. Likewise, all

operational records must be accurate, timely and conform to Heerema Marine Contractors' requirements. Suppliers must create, retain and dispose of business records in full accordance with applicable legal and contractual requirements.

Conflict of Interest

Suppliers must disclose any potential conflicts of interest to Heerema Marine Contractors for review prior to entering into any business transaction. A conflict of interest exists any time there is a choice between a personal interest (financial or otherwise) and the interests of Heerema Marine Contractors. A conflict may arise with Suppliers that employ or are partially or fully controlled by a Heerema Marine Contractors employee or family member. Suppliers, their employees or their family members cannot receive improper benefits through the relationship with Heerema Marine Contractors or allow other activities to conflict with acting in the best interests of HMC's clients.

Gifts and Entertainment

Suppliers must not give any personal fees, gifts, favors, other compensation or business courtesies that are intended to influence, or appear to influence, a business decision. Heerema Marine Contractors maintains high standards in this regard and is sensitive to even the appearance of improprieties. Suppliers failing to observe this guidance could be disqualified from conducting business with Heerema Marine Contractors.

Supplier Diversity

Heerema Marine Contractors recognizes that a strong, diverse supplier community is essential to economic vitality and proactively seeks opportunities to conduct business with competitive, diverse suppliers. We also expect our business partners to utilize and develop diverse suppliers while performing work on our behalf.

Employment Practices

Suppliers must conduct all their operations in a socially responsible, non-discriminatory manner and in full compliance with applicable laws including, but not limited to, those associated with Equal Opportunity, Child Labor, Forced or Compulsory Labor, Working Hours, Wages and Benefits, Freedom of Association, and Harassment-Free Work Environment.

Compliance with Laws, Rules and Regulations

Suppliers are required to comply with the letter and intent of all applicable legal requirements including those dealing with bribery, kickbacks, corruption and other prohibited business practices. The antitrust laws and Foreign Corrupt Practices Act of the United States prohibit a wide range of transactions or practices by both purchasers and sellers of goods and services. Heerema Marine Contractors intends to comply fully with these laws.

Business Continuity

Heerema Marine Contractors' products and services provide critical infrastructure to our customers. Therefore, our Suppliers are expected to have plans in place for their business operations to continue

with minimal interruption of supply in the event of an emergency, crisis situation, natural disaster or terrorist/security related event.

Continuous Improvement

We are committed to continuous improvement and strive for best practices in our business. We recognize that Suppliers have experience in multiple companies and industries, and encourage Suppliers to identify opportunities for improvement in our work practices.

Compliance

Ethical Dealings

Heerema Marine Contractors always engages in the highest ethical practices in source selection, negotiation, award decisions and the administration of purchasing and sourcing activities. Heerema Marine Contractors requires Suppliers, their employees, and subcontractors to comply with the Supplier Code of Conduct requirements. We reserve the right to conduct visits to verify that a Supplier's business operations meet the expectations outlined in this code. Remediation plans will be developed for significant deficiencies. Failure to address significant deficiencies within a reasonable time may result in cancellation of contracts.

Questions or Concerns

Suppliers, their employees, or their subcontractors must report any questionable behavior by Heerema Marine Contractors employees or suppliers. Fraudulent financial reporting, misappropriation of assets, corruption and other fraud related malfeasance, illegal activity, fiscal waste or abuse, or other suspected violations by any party shall be reported in accordance with the Heerema Marine Contractors Nederland BV Whistleblower Policy.

We encourage open discussion regarding any concerns with this code or in our business relationship.