SUPPLY CHAIN STRATEGY IN AKER SOLUTIONS

- with focus on the kraljic purchasing portfolio model in the epc industry

CONFIDENTIAL

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Preface

This Master Thesis represents the final paper of the Master of Science degree in Industrial Economics and Technology Management within Business and Mechanical Engineering at the Norwegian University of Life Sciences. The thesis is performed in cooperation with Aker Solutions through Aker Engineering & Technology located at Fornebu, outside Oslo.

The thesis was initiated by me, who since the summer of 2011 has had a part time position within the company. During the time in the Procurement Department as a summer intern and assistant it inspired me to choose Supply Chain as field of study for the Master Thesis.

The process of narrowing down a suitable topic and thesis statement was completed with the support of Supply Chain Manager at Aker Engineering & Technology, Mr Rune Andersen. Mr.Andersen has extensive experience in all levels of Supply Chain Management, which would turn out to be of significant importance of guiding me through the process of writing this thesis. Mr.Anderson has been very supportive and instrumental to my work. Mr Anderson has therefore functioned as both a company contact as well as external supervisor in my thesis work.

The internal supervisor at the university, Jens Bengtsson has helped and supported me in many of the same ways as Mr.Anderson. Mr.Bengtsson supervision has had a more academic emphasis. Mr.Bengtsson has been a great sparring partner in terms of finding the theoretical path that seemed most fitting.

I would like to thank Mr.Rune Anderson and Mr, Jens Bengtsson for their support and guidance throughout the thesis work. I would also like to thank my skilled co-workers at Aker Solutions and Kvaerner for their encouragement and contributions, and especially Mrs. Lena Madrid for the proofreading of the thesis. Thank you my dear Amanda Ystebø for great understanding and support both throughout this thesis and throughout my studies.

Carl Petter Larsson – Oslo, 01.08.2012

Abstract

The Master Thesis is completed in cooperation with Aker Engineering & Technology's Supply Chain business area, a part of Aker Solutions ASA. The company delivers fully integrated onshore and offshore facilities to oil companies worldwide. The Supply Chain unit of Aker Engineering & Technology is specialized in the procurement of equipment items. In order to meet the market competition of this business the company is constantly developing its strategies in terms of possible ways to ensure a sustained competitive advantage.

The thesis statement is related to how Aker Solutions can establish a higher competitive advantage by carrying out strategic moves in terms of the purchased equipment in the projects. The purpose has been to find different ways to establish information sources and planning tools of the procurement strategy for future projects, by using an on-going project as a presumption. The academic purpose of this thesis is to contribute to extend the knowledge base of purchasing portfolio models. The thesis is based on purchasing portfolio modelling and transaction cost theory

The theory of transaction costs has been used as an underlying assumption for revealing the cost drivers in a purchasing organisation and towards the use of vertical integration as a possible future strategy.

The purchasing portfolio theories are based on Peter Kraljic's model from 1983 for distinguishing and characterize different items. The model is a two dimensional matrix model of supply risk and profit impact.

The matrix is customized and created through qualitative half-structured interviews with key-personnel primary from management positions in the company. The intention of this was to recognize the company specifics and critical factors related to the purchasing in Engineering Procurement Construction-projects, also called EPC-projects, in the company. The established model was subsequently utilized through a questionnaire answered by senior buyers, which enabled matrix positioning of selected equipment items in the on-going Eldfisk 2/7S-project. An excel spreadsheet was also generated to enable further use of the company customized model.

The matrix yielded a model of the actual positions of the selected items. the model can, from a strictly theoretical point of view describe an outline in which direction Aker Engineering & Technology could benefit from in terms of future strategy. The evaluation either determine withholding or moving the item position, depending on where the item is positioned in the matrix, by utilizing different strategies.

The final conclusion of the thesis in terms of the statement argues for less complicated purchasing process when dealing with items with low supply risks and profit impact. It is also argued for active supplier development and possibly vertical integration strategy in high supply risk items.

Sammendrag

Denne masteroppgaven er utført i samarbeid innkjøpsorganisasjonen ved Aker Engineering & Technology som er en del av Aker Solutions ASA. Selskapet leverer fullt integrerte onshore- og offshoreanlegg til internasjonale oljeselskaper. Innkjøpsenheten er spesialisert på utstyrsdelen av innkjøpet som utføres. For å imøtekomme den økte konkurransen i markedet er virksomheten i stadig utvikling for i størst mulig utstrekning øke sitt konkurransefortrinn.

Problemstillingen er knyttet til på hvilken måte Aker Solutions kan øke konkurransefortrinnet ved å gjennomføre strategiske trekk i forhold til innkjøp av utstyr i deres prosjekter. Hensikten med dette er å finne mulige måter å planlegge innkjøpsstrategi for fremtidige prosjekter, ved hjelp av pågående prosjekts innkjøpskarakteristikker. Masteroppgaven benytter transaksjonskostnadsteori og porteføljeteori for å analysere dette.

Transaksjonskostnadsteori er blitt brukt i oppgaven som en underliggende kunnskapsbase for å avdekke kostnadsdrivere i en innkjøpsorganisasjon og brukt i forhold til vertikal integrasjon som en mulig fremtidig strategi.

Porteføljeteorien brukt i oppgaven er basert på Peter Kraljics porteføljemodell fra 1983, og blir brukt for å skille og karakterisere ulike produktene fra hverandre. Modellen er en todimensjonal matrisemodell bestående av to akser, representert ved forsyningsrisiko og innkjøpets betydelse for prosjektet.

Matrisen er tilpasset og modifisert gjennom kvalitative halvstrukturert intervjuer med nøkkel-personell fra lederstillinger i selskapet. Hensikten med dette var å finne de kritiske faktorene knyttet til innkjøpet som gjøres i Engineering Procurement Construction-prosjekter i selskapet. Den utformede modellen ble deretter testet og brukt til å kategorisere utvalgte produkter i det pågående prosjektet Eldfisk 2/7S. Dette ble gjort gjennom å benytte et spørreskjema som ble besvart av til dels erfarne innkjøpere. Et Excel-regneark er også blitt laget, for å muliggjøre videre bruk av modellen for selskapet i en senere anledning.

Resultatene kommenterer de faktiske posisjonene til de utvalgte produktene fra et teoretisk perspektiv, og beskriver i hvilken utstrekning disse vil være gjeldene for

selskapet, og på hvilken måte man kan benytte fremtidig strategi til dette. Evalueringen argumenterer for enten beholde posisjonen i matrisen, eller å bruke fremtidig strategi til å bevege seg til en annen ønsket posisjon.

Den endelige konklusjonen tar utgangspunkt i problemstillingen og argumenterer for å gjennomføre mindre komplisert innkjøp i tilfellene der innkjøpet er karakterisert med lav forsyningsrisiko og lav betydning for prosjektet. Det er også argumentert for aktiv leverandørutvikling og delvis vertikal integrasjon der tilgjengelighetsrisikoen er høy og innkjøpet har stor betydning for prosjektet.

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1 Introduction

The intention of this chapter is to introduce the study topic and deduce the context of the report and its methodology. It reviews the thesis statement and the background for selecting the area of study. Finally it describes the purpose of the study and its limitations.

1.1 Background

Aker Solutions operates in a global market environment where high quality and complex projects are a definite requirement. Dynamic and high value projects are executed simultaneously and expected to collaborate with each other to meet the customer's expectations. Project of this nature can change rapidly as the projects get executed and barriers and limitations are uncovered. The oil and gas market has through many years evolved internationally, and is now a globally oriented market. Aker Solutions in general, operates in a segmented business with many different clients in several sub-markets within the industry. Therefore the company are constantly working towards multiple projects and products that meet the customization required to meet the demands of the client. These requirements are product and client dependent, however all markets share the common demand of cost effective, time saving projects and the ability to deliver the right quality.

The supply chain challenges in Aker Solutions and Aker Engineering & Technology are similar to many other companies. The need for continuously improvement and achieving a sustained competitive advantage in the market is always present. The company is therefore constantly developing its business throughout the world. The opportunity to enter new markets and use the rapid growth in some of the low cost countries has been practiced, and several offices around the world have already been established. If this is determined beneficial and are corresponding with the established overall strategy, this can be further taken advantage of by bringing in more supply activities.

The Engineering Procurement Construction (EPC) Projects are one of the company's primary business areas and the selected topic for this thesis. Other business areas such as Aker Subsea are excluded from this thesis. A typical EPC-project consists of

delivering a full scale facility including all equipment for operating the oilfield or gasfield, and is purchased by the Procurement Department within the project organization.

The procured items are divided in so-called bulk or equipment “packages”. The designation of bulk and equipment depends on the specifications, quantity of the equipment. The primary of this thesis are equipment packages, recognized as one-of items, and are considered the most commercially significant in Aker Engineering & Technology.

The procurement of the project packages are in many cases characterized by high supplier power due to the peculiarities of the goods. The purchase is thereby performed in typical niche markets with more or less oligopoly market characteristics. The lack of competition in these markets generates a problem for the purchasers, who among others are Aker Engineering & Technology.

Another characteristic of the supply chain is the lack of different approaches in the procedures regulating the procurement process. All equipment seems to be procured with identical framework of contractual requirements. Today the company does not distinguish between typical shelf-items and high-complex items.

The above statements imply that it is possible to organize and strategically approach the procurement process could be beneficial for the company. In order to establish benefitting strategy plans for the procurement related activities in the company, the development in low cost countries is something that would require an allocating of packages.

1.2 Thesis Statement

The thesis statement is based on my understanding of the business, and what problems Aker Solutions encounters in the supplier relations within EPC-projects. Following topic was raised to generate a thesis statement corresponding with the problem background in the above section.

The assignment will describe the international supplier market Aker Solutions has the opportunity to exploit. It will focus on how the company can distinguish items and increase competitive advantage by reducing supplier costs in the projects, while retaining sufficient technical quality, with minimal own risk.

A set of more defined problems was identified, that should work as the main target for the assignment, throughout the thesis, and which will be fully answered in the conclusion.

1st Thesis statement

- *Would it be beneficial for AE & T to work with active supplier development or/and vertical integration strategy in low cost countries?*

2nd Thesis statement

- *What factors must be evaluated to get the most benefit from this?*

The thesis statement has also been used as a guideline in the study period to identify the direction of the thesis development. This has helped me to keep the determined path throughout the thesis work, and ensuring a conclusion corresponding with the thesis statement.

1.3 Purpose

The purpose of this study can be divided into two main categories, these two categories are; 1) the purpose in relation to the company, and 2) the academic purpose. These two purposes should be distinguished because of the different agenda which lies as a background basis for the two agencies. The academic purpose is related to the final work of my Master's degree, i.e. the degree of mastering a scientific study with all its premises. The company purpose is more or less only connected to the possible business benefit and the reports result and conclusion. Despite the differences in purpose, the overall importance of validity and reliability remains the same.

The academic purpose of this Master Thesis is to generate a possible theoretic approach. This is done by showing how a supply chain strategy can be developed by using already established theories, in this case the Kraljic Purchasing Portfolio Model. This thesis has the purpose of generating more knowledge within the purchasing portfolio theory. However, this is to some extent limited through the thesis confidentiality, which is required by Aker Solutions.

The business purpose of the study is to develop an effective and reliable method for distinguishing procured items. This is needed to establish strategy development plans within the supply chain unit of the EPC-contracting business area. A secondary purpose of creating a model for further use has also emerged through the thesis period, and is presented accordingly.

The study is intended to represent a point of view and a suggestion from both inside and outside the company, since the author is both working in the operational level of the business area and are composing the study as a student in the Master of Science study of Industrial Economics and Technology Management at the Norwegian University of Life Sciences.

1.4 Subject Limitations

The study is to some extent limited in its methodology. Certain limitations such as described below were established before the study began, however some have also been discovered throughout the study period. Following text will describe these major limitations and the decision base for the established boundaries.

The overall strategy of Aker Engineering & Technology has lately been limited to the procurement of equipment items. These items are generally high-complex items, and are typically procured one at the time. The excluded items from this study are therefore the items known as bulk, which is typically procured in numerous quantities. The study is thereby written with emphasis only on these items within EPC-projects and the company, and project specifics. However, through adjustments and precautions the study can be used in comparison to other similar projects.

The major research area of this study is the customized purchasing portfolio model; it implies that the majority of research resources have been utilized to create a reliable and valid model. Alternatively another allocation of resources could have generated a higher level of final strategy recommendations; however it was preferred to generate a model for further use. The establishing of specific strategy plans would in any case be grounded on a relatively low decision base, due to the nature of this study.

Through the theoretical framework the study reviews the both transaction cost and purchasing portfolio theory. This refers to the contractual implications of complex procurement, vertical integration and the established model in the analysis chapter. Other theoretical views such as active supplier development and outsourcing to low cost countries as strategic options are reviewed by the author briefly, but not included in the study due to the above mentioned reason of resource allocation.

The assumptions and conclusion are based on and thereby limited to the results of the qualitative interview sessions, authors' short time professional experience and the general economic theory from university courses.

In this study market analysis is not conducted. The oil and gas supplier industry market proved to include a vast niche market where I had limited or no knowledge base. This would also if attempted be of less benefit since the company already has extensive and in-depth knowledge in this area through its employees.

1.5 Abbreviations

AE & T	Aker Engineering & Technology
ABC	Activity Based Costing
EM	Engineering Manager
EP	Engineering Procurement
EPC	Engineering Procurement Construction
EPCI	Engineering Procurement Construction Installation
FEED	Front-End Engineering & Development
HSE	Health Safety & Environment
HVAC	Heating Ventilation and Air Conditioning
PEM	Project Execution Method
PM	Procurement Manager
PRB	Package Responsible Buyer
PRE	Package Responsible Engineer
QS	Quality Surveillance
ROC	Return on Capital
ROI	Return on Investments
TCE	Transaction Cost Economics
VI	Vertical Integration
WBS	Work Breakdown Structure

2 Company Specifics – Aker Solutions ASA

Aker Solutions ASA has over the last decades developed a company strategy for executing large scale projects in a way that are effective, cost optimizing and quality sufficient. This has led to great competitiveness in the contracting markets of projects in the oil and gas sector. Oil companies such as Shell, Statoil, BP, ConocoPhilips and many more view Aker Solutions as one of the best companies in the EPC market. Their main focus spans from oil and gas field development to commissioning and installation of oil and gas facilities both on and offshore.

AE & T is one of several divisions in Aker Solutions ASA, Aker solutions' history can be traced back to the middle of 18th century. The Company has gone through several mergers, fissions and name changes with other companies since then. The company is now known for the excellence in providing technical and high cost success projects.

"*Today Aker Solutions is a fully-fledged provider of EPC field development projects as well as engineering, technologies, solutions and services for the upstream oil and gas industry. Our range of offerings include deep-water drilling technologies, Subsea oil and gas production systems, well services, mooring and offloading systems, well-stream processing technologies, as well as life-of-field solutions through its maintenance, modification and operations business. We are also a dedicated EPC contractor for onshore and offshore oil and gas facilities."*(Aker Solutions website, 13.05.2012)

The company is structured in several different business areas as seen in the corporate structure, figure 1.5-1. Aker Solutions has about 18 500 employees in about 30 countries (Aker Solutions Internal net), making Aker Solutions one of the most international companies in Norway. For 2009 and 2010 the revenues were over 54 and 46.2 billion NOK respectively. The company is divided into 9 units where every unit has several offices across the world.

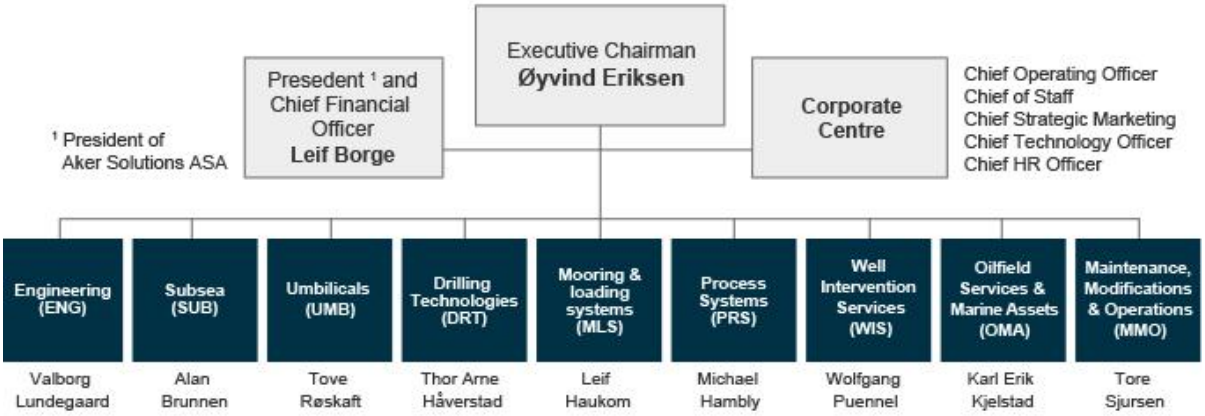


Figure 1.5-1: Aker Solutions Organization Chart, Source: Aker Solutions Internal Network

2.1 Aker Engineering & Technology

Aker Engineering & Technology consists of seven different AE & T companies located in seven different countries around the world. The black marks in figure 2.1-1 shows AE & T's geographic spread in the world, while the orange marks on the map shows other Aker Solution offices. The Norwegian AE & T Headquarter is located at Fornebu outside Oslo, while the other offices are located in Moscow, London, Shanghai, Beijing, Kuala Lumpur and Mumbai. These generate the baseline of engineering within the company.

Figure 2.1-1: Aker Solutions World Locations, Source: Aker Solutions Internal Network

Aker Engineering & Technology (AET) is a leading international provider of front end studies, engineering, procurement and project management services needed for initiating and undertaking of contracts for the oil and gas industry, both onshore and offshore. The company is also a major contributor of new technology and products, new knowledge and new methods for efficient cost-saving and environmentally

friendly exploitation of the world's oil and gas reserves. (Aker Solutions website, 13.05.2012)

The turnover for AE & T's Fornebu Headquarter was in 2009 and 2010, 3.9 and 3 billion NOK respectively. The headquarter houses the basis management for all disciplines and decision making units. The basis management organize and govern personnel use and allocation of recourses in projects which is awarded by the company. Because of the company's many offices it is possible to execute projects at competitive low cost; one example of this is Eldfisk 2/7S-project. The Eldfisk project has a main engineering hub at Fornebu. Some of the engineering is nevertheless completed in Mumbai, India, enabling the company to reduce baseline cost of the project.

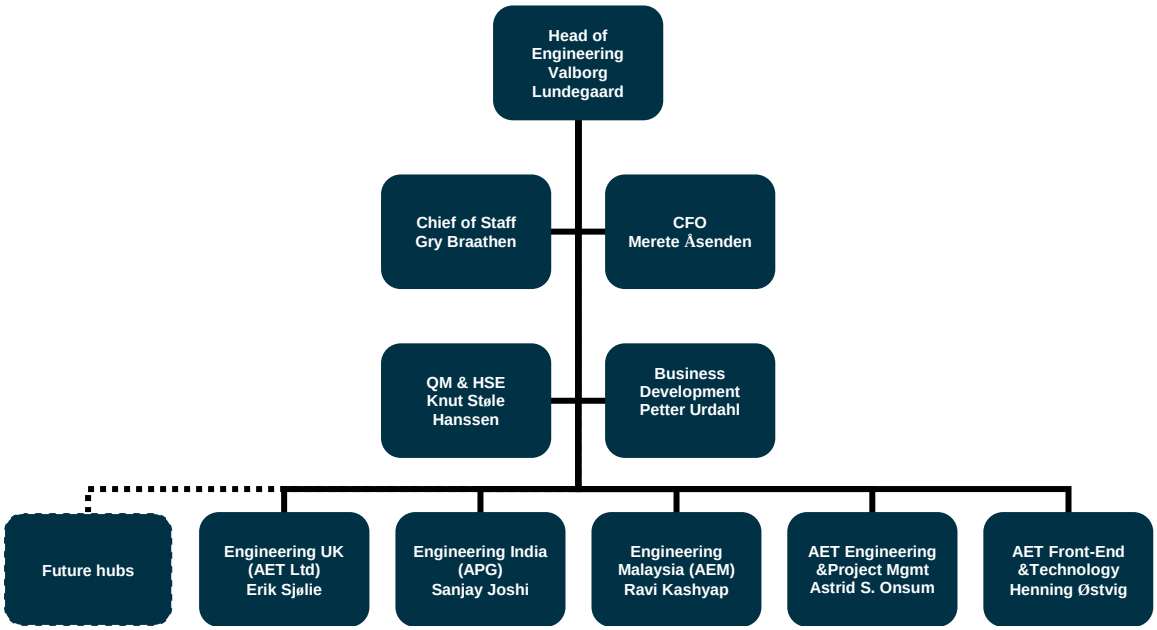


Figure 2.1-1: AE & T Organization Chart, Source: Aker Solutions Internal Network

2.2 Project Execution Model – PEM

The Project Execution Model (PEM) is a great competitive tool for Aker Solutions and are one of the reasons the company's getting big sized projects. This model is a schematic view of how it executes projects using WBS (Work Breakdown Structure). With this tool the company has a way of controlling the large amount of manpower and organizational difficulties around each project.

For every project, the Aker Solutions PEM gives a defined structure and approach when executing projects for customers, as well as assisting in providing more

effective work processes, enhanced communication, better information flow and increased quality of delivery (Aker Solutions Internal Network). Within the company's PEM, we find several areas of interest when it comes to supply chain management. All projects in AE & T define and lay the base for an EPC-project. This text will give a quick overview of the PEM-model which you can see in figure 2.2-1.

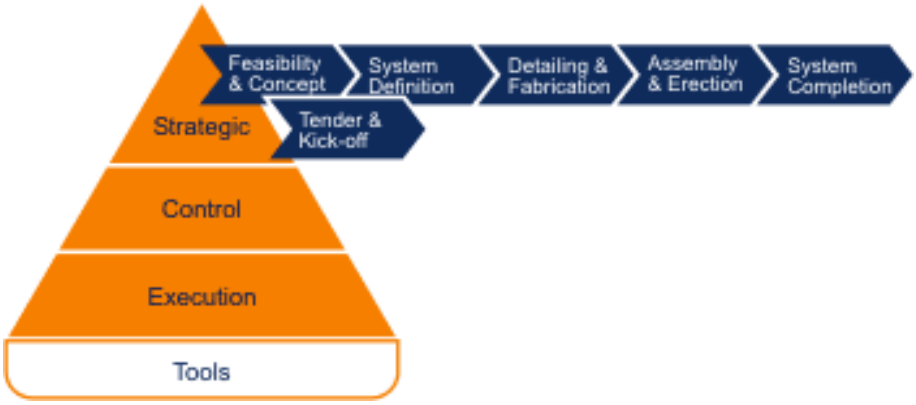


Figure 2.2-2: PEM Overview, Source: Aker Solutions Internal Network

The PEM is not only organized in both the strategic, control and execution phases in the company, but also throughout all divisions in the company. In this way employees will always have to operates within its own unique part of the model whether you are an executive in engineering or employed as a buyer in procurement. This means that in terms of the model, almost every position in the company has a job description directly linked to the PEM.

The model consists of five main phases which is Feasibility & Concept, System Definition, Detailing & Fabrication, Assembly/Erection and System Completion. Respectively the phases lay the ground for how the projects are executed, either if it is only a concept study of an oil field, or a big EPC-project (Engineering Procurement Contracting) for delivery of an installed platform.

Each contract AE & T wins becomes a project with a unique entry and exit point in the PEM. The company emphasizes a great deal on getting the right entry point for each project, to ensure a smooth start-up process, which increases the execution quality throughout the project timeframe. Another part of them PEM that makes it successful is the way it is constructed. It has several quality improvement focus areas that let the employees report back strengths and weaknesses of the model as its

being used. This ensures continuously enhancement of project delivery and quality to customers.

In some cases AE & T is responsible for the entire process in an oil field development. The different phases within the development are usually divided into several contracts. In these cases the company has to win the tendering process for every contract an oil company puts out on the market. The following chapter will give an overview of these common types of contracts.

2.2.1 Project Phases

The type of contracts in these industries can vary depending on the specifications given in each project. The contracts are built up in the same way as the PEM and thereby built up around emphasizing on the industry. When developing an oilfield with intention of building an oil platform, the process consists of several phases as mentioned in previous section. In most cases the projects are referred to slightly different than the PEM reference, because the contracts extents independent of the PEM milestone limitations. The typical main categories of the contracts are divided into typical projects which in many cases are referred to as:

- Concept study projects
- Front End Engineering and Design projects
- EP/EPC/EPCI projects

Consept Study Projects

The concept study projects are based on the investigations and strategy of each oil company and their development of the oil field. This is usually the first step for the oil companies of outsourcing to companies that are specialized in upstream petroleum industry, within development. These projects concentrate on the technical requirements and the cost impacts of choosing different processes and facilities, with regards to the petrochemical quality and different facility solutions. The project has the intention to find further strategy and specifications and extend the contractors decision base in terms of the FEED project phase. The contact specification for this project is limited mostly to process technical engineering work.

These studies are allocated in the first phase of the PEM. These kinds of studies are a separate unit inside AE & T, performed by separate engineers and is specialized in

oil field development. AE & T delivers through its unit a general outline for further scope of work in the next project phase. The work is focused on finding the right petrochemical process for the unique well-stream that will enter the facility. You will in this project among other details uncover how many separators and processes you will need to get the right commercial quality for the oil product. The process information along with location will also be a factor for choosing type of facility.

When it comes to suppliers, the project selects the equipment, and ensures that it is available on the market. These projects focus on engineering and technical solutions for the facility. This implies that most commercial questions covering supply chain are postponed to later project project-phases. In figure 2.2-2, which shows first PEM phase these project are typical running from milestone 1A to 1B.

Front-End Engineering and Technology Projects

The following project contract phase is known as FEED projects. The company goes further in developing the scope of work for the actual coming EPC project. These projects are in mainly focused on setting up and detailing the scope of work for the EPC project. In general this phase does all the main selection and defines all equipment needed for the facility. After the FEED, the EPC-project, i.e. procurement and detailing engineering, starts. The petrochemical process is decided and the company now knows exactly what equipment and the approximate quantity that is needed. This is also the most interesting phase in terms of the supply management, because the project starts focusing on suppliers for the coming phases. The commercial part of procurement is at this point defining the vendors, i.e. creating supplier long lists for equipment packages which are to be used in a coming bid process at EPC-phase. In this phase all the frame agreements are also made, together with planned single-source strategy.

The frame agreements that are made for certain equipment, have the intention to reduce risk in market where needed. Another reason can be that neither the oil company nor AE & T has their own frame agreements with some equipment suppliers, where the company is obligated to choose this in project. The long list is based on the company's experience and the unique market situation on equipment that is to be procured in an EPC project. Many of the vendors that could be suitable

for a bidding process are contacted and requested to supply information regarding product and certifications that are project requirements, such as ISO9000 certification and NORSOK standards. The figure under shows this project milestones and are typical milestone 1C to 1D.

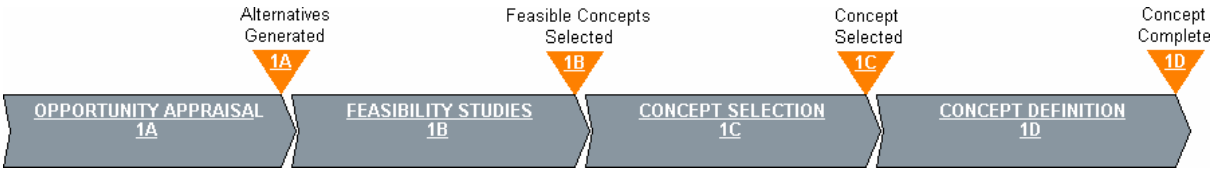


Figure 2.2-3: PEM Milestone 1, Source: Aker Solutions Internal Network

EP/EPC/EPCI Projects

The last common projects are the EP/EPC/EPCI projects, which are the largest ones both in cost and time spent. These contracts have variations in the complexity of the scope of overall projects. The wording (EPCI) refers to Engineering, Procurement, Construction and Installation. This dictates the contract contents and the EP (milestone 2A to 3A in figures below) projects have less workload than the EPCI (milestone 2A to 5D in figures below) projects. While the EP projects cover the Engineering and Procurement, the EPCI also covers the construction and installation. The EPC also is divided similar, and ranges from 2A to 5A. Whenever a contract is awarded, some parts can be outsourced depending on the contractual specifics and intention of the awarded company. The company is obligated to deliver a full scale running facility in as agreed in contract with the oil company. The main focus in this project is based on earlier projects to procure all engineered items needed to build, erect and install the facility (i.e. an EPCI-projects).

Figure 2.2-4: PEM Milestone 2, Source: Aker Solutions Internal Network

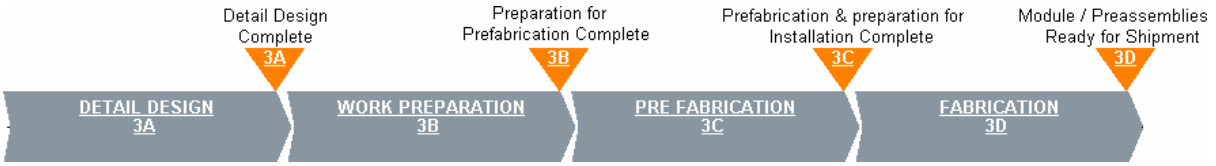


Figure 2.2-5: PEM Milestone 3, Source: Aker Solutions Internal Network

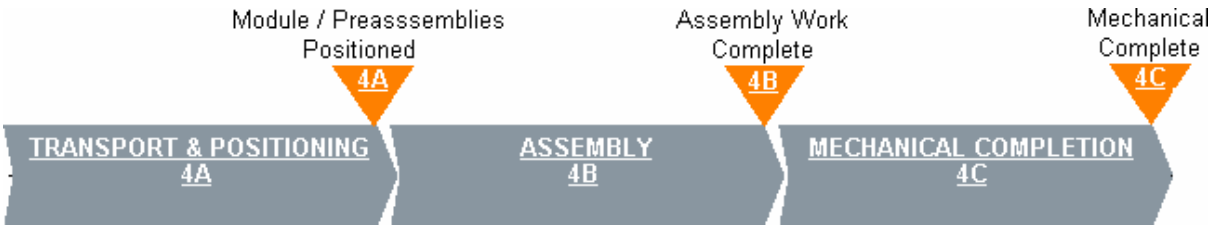


Figure 2.2-6: PEM Milestone 4, Source: Aker Solutions Internal Network

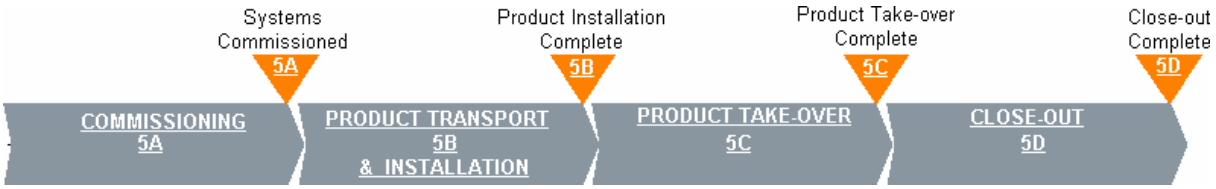


Figure 2.2-7: PEM Milestone 5, Source: Aker Solutions Internal Network

2.3 Cost Reduction Potential

There are several points of view that need to be evaluated when it comes to the question of which phase that has the best potential for cost reduction. There are different ways of setting up contracts that will give different perspectives of the cost reduction and who it affects. Another question is who is benefiting from the overall supplier cost reduction? AE & T can benefit if cost reduction reduces their cost, but the AE & T can also strengthen their competitiveness if they share the reduction with clients such as the oil companies.

The view of which phase that yields the biggest cost impact can be explained by looking at an overall project timeframe. In general it can be assumed that as the project is developing and gets executed, the cost reduction potential tend to decrease. This means that earlier phases should be the main focus if the intention is to look for overall supplier cost reduction. In this way it is natural for this master thesis to focus on the overall supplier strategy in the early project phase and before the EPC-phase where most decisions are already in operation, in terms of suppliers, and where execution and time are the most critical factors. Therefore, analyses of a late project phase (i.e. an EP, EPC or EPCI-project), will generate a supply knowledge of how one can achieve reduced cost in future projects. Acquiring such information can be critical for developing further strategies, which can be applied early in similar projects, and generate cost reduction with a great potential since this can be applied in early projects. This will then affect the bottom line cost of the project cycle for each individual development.

The project chosen for this assignment and coming analysis is the EPC project Eldfisk 2/7S. This is a Kvaerner project, executed by both Kvaerner and AE & T personnel. Following subchapter will emphasize the structure and operational characteristics of this project, generating a baseline for the analysis in the thesis.

3 Eldfisk 2/7S - Project specifics from a purchasing point of view

3.1 Brief Project Description

The Eldfisk 2/7S-project is a full scale EPC contract awarded Aker Solution by ConocoPhilips Skandinavia AS. The contract consists of Engineering, Procurement Construction of the Eldfisk 2/7S topside. The Eldfisk 2/7S is a new wellhead, process and accommodation platform supported by a steel jacket. It also includes the bridge system linking a flare tower and the facility to the existing Eldfisk 2/7E-platform. Figure 3.1-1 gives an overview of the platform with the two bridges, and the existing facilities in red colour.

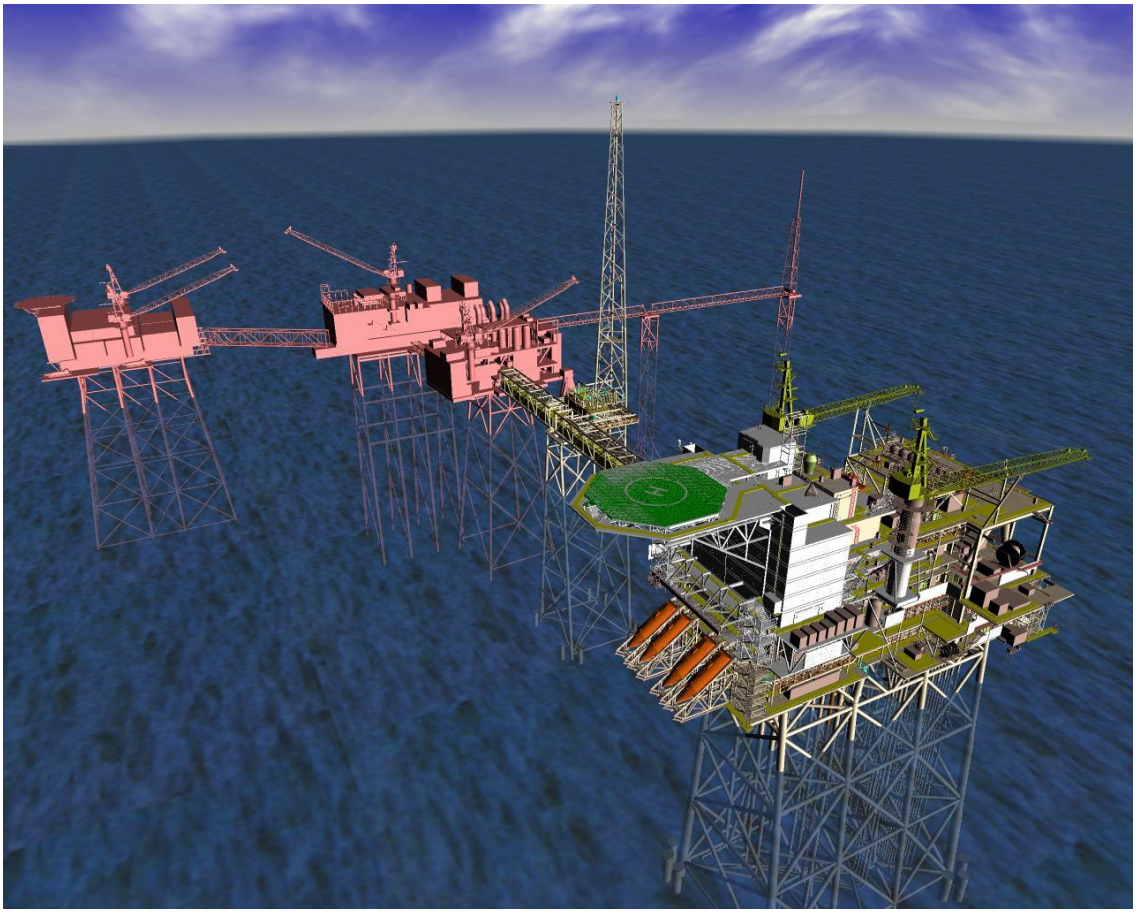


Figure 3.1-1: The Eldfisk 2/7S-topside, Source: Eldfisk-Project Internal Network

The procurement part of the project includes all purchasing activities related and required for delivery of this topside, including the bridges and flare tower top facility. To meet project requirements a procurement division with sufficient manpower is established within the project, working close with the engineering disciplines.

3.2 Project Organization

The procurement personnel in the project are organized close together with Quality Surveillance (QS) personnel and together they form the procurement team as showed in figure 3.2-2. The project organization is set up to enable the engineering department to work closely to procurement. The material and equipment that is procured is allocated in packages, the categorization of these are explained later in the text. For each package there is one Package Responsible Buyer (PRB) with the overall commercial responsibility and one Package Responsible Engineer (PRE) with the overall technical responsibility. The PRE communicates with all the engineering sub-disciplines which are applicable for each package.

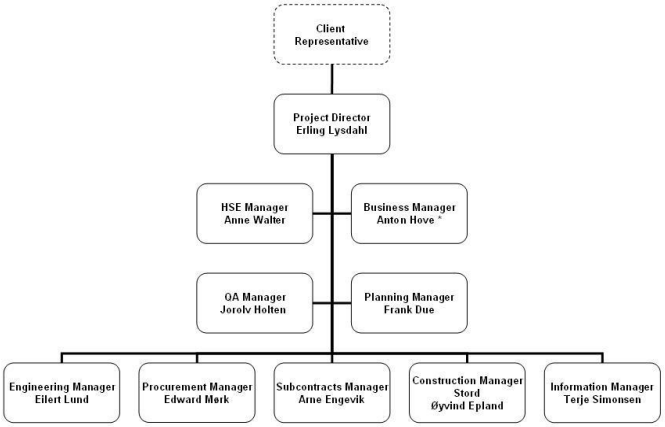


Figure 3.2-1: Eldfisk-Project Organization Chart, Source: Eldfisk-Project Internal Network

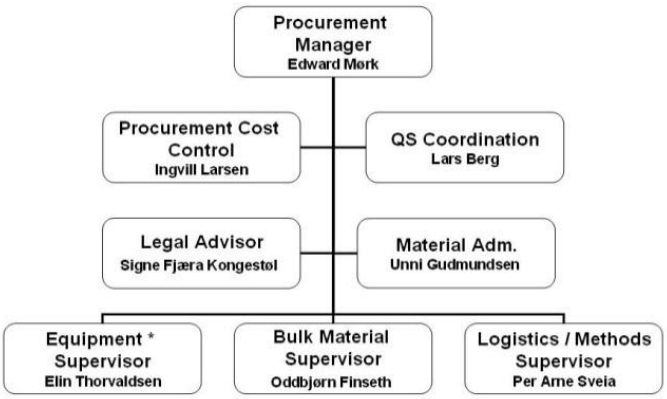


Figure 3.2-2: Eldfisk-Project Procurement Organization Chart, Source: Eldfisk-Project Internal Network

The Procurement Manager (PM) has the overall responsibility for coordinating the procurement activities, and is supported by the Procurement Cost Control, Legal Advisor, Material Administration and QS Coordination. Together with the Engineering Manager (EM) the PM ensures efficient communication and interfaces between the PRE and the PRB, PM and EM reports back to the Project Manager. The

procurement and engineering teams maintain close contact with the client (i.e. ConocoPhilips), and are reporting regularly through formal correspondence and weekly status meetings. The day-to-day work also offers a close connection with the client who has a project organisation located in the Aker Solutions facility. The close proximity ensures the surveillance requirements from the client, and ensures relationship building between client and contractor (i.e. Aker Solutions).
The procurement team has in general several responsibilities that are listed under, and represent an overview of the procurement related activities defined in the project. These are defined by the client.

- Establish and prioritize procurement packages for equipment, bulk and other materials, based on the technical specifications and other requirements defined by engineering and the contract.
- Ensure that supplier documentation and information is delivered with the required quality to:
    a) Suit and support Project engineering activities and
    b) Meet the specifications and requirement for Final Documentation of the Project.
- Ensure that equipment, bulk and other materials are available for use at the pre-fabrication, construction and offshore installation in accordance with the project specification, requirements and schedule.

3.3 Package Classification

The classification of packages in the project is based on the organizational structure, in terms of disciplines, but also according to types of items. The earlier text has referred to the packages as bulk or equipment, which represent the two main categories of the purchased items in the project. The PEM defines a number categorisation for package recognition based on two letters and three numbers. This makes the packages easy to recognize across projects. The numbering system is explained in figure

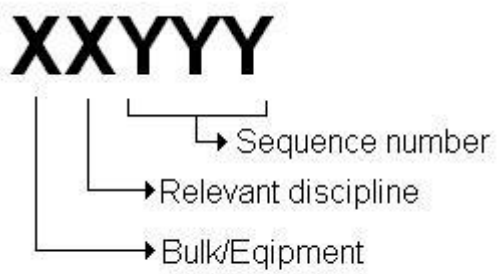


Figure 3.3-1: Package Numbering, Source: Author

3.3-1. The categorization represents the first letter in the code from the figure.

- Bulk items: Items that represent quantity order, typical items are steel plates, piping material, bolts and nuts, steel gratings etc.
- Equipment: Items that are “tagged”, typical “one off” products that are customized. Typical products are separators, valves, generators etc.

The next letter in the package number reflects the relevant discipline of the package. The numbering system is based on NORSOK Coding Standard (Z-DP-002) in terms of discipline codes. Further the three last digits has a generic system where 0-500 represents equipment, 500-999 represent bulk, and where each discipline has their unique sequence allocation. As an example the package referred to as “ER350” is an equipment (E) package in the discipline Mechanical (Ref. discipline “R” in NORSOK Coding Standard). The three digits are within the 240-359 range, which is allocated for mechanical packages. This assignment will not further discuss bulk equipment, and will not be a part of the analysis due to limit of the assignment in this master.

3.4 Purchasing Process

The purchasing process in Eldfisk 2/7S EPC-project is determined both by the client and the company’s procedures. The establishment of many packages is already settled in the FEED phase, however there are several new established packages based on the practical purchasing in this project phase. Packages can be split up or merged together if this is reasonable for the practical purchasing procedure.
The buyer has several procedures that is subject for evaluation by the client, and ensures clients insight to the progress of the project. Below, some of these formal procedures are listed.

- Criticality assessment: Form filled out by PRE and PRB and rating the package in a weighted criticality level in terms of HSE, Commercial and Technical risk.

- Bidders list: An overview of which suppliers that will be included in a bid process for the package. This list should be based upon Achilles Web based supplier database.

- Short List: An evaluation report containing the bids received from suppliers, and which supplier the company selects for further evaluation.
- Selected Bid Summary Report: An extended and final version of the Short List, including spreadsheets with weighted scores in terms of HSE, Commercial and Technical (weights from Criticality Assessment).

The formal reporting generates an evaluation and approval base for both the client and the company towards the supplier. This does not apply to packages that have frame agreements; this will be explained later in the text.

3.5 Awarded Suppliers in the Eldfisk-project

The assignment focuses on the equipment suppliers with contracts awarded before 15th of May 2012. As this project is still on-going, there has been a need for setting a deadline towards the suppliers that are to be analysed. The majority of equipment suppliers have received contracts before this date.The suppliers awarded in the project are primarily from Norway and other European countries.

There are 9 different discipline categories included in the equipment packages in the project. Most of the packages contain mechanical and instrumentation equipment, which is showed by figure 3.5-1.

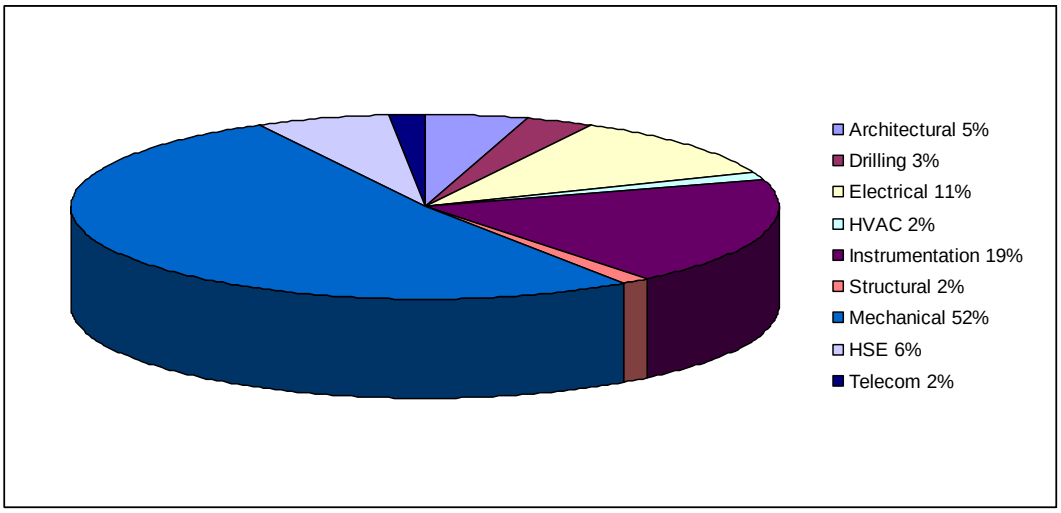


Figure 3.5-1: Discipline overview, Source: Eldfisk-Project Internal Network

The equipment packages has a range of prices, the figure is not adjusted for price, which means that the picture could be different if cost where included in the figure.

Packages have a great span when it comes to cost, where some are around 1 million NOK, others are around 100 million NOK.

3.6 Agreements

The agreements handled in the project can be divided into two sets that define the PRB's job of handling the package. The two sets are can also be divided into two additional groups that go even further in defining the scope of work for the buyer. Following types are present in this project.

- Purchase Orders, which either are;
    a) Competitive bidding, or
    b) Single/Sole Source
- Frame Agreements, which either are;
    a) Mandatory, or
    b) Optional

The purchase orders are based on competitive bidding among the potential suppliers that receives an inquiry from company. The client demands a minimum quantity of bidders to ensure effective and competitive bid-process. In special cases where a single supplier is preferred by company due to an extra ordinary reason a single source can be justified. In order to pursue this kind of purchase the company must issue a report for approval by client which argues for such sourcing. These agreements are referred to as Purchase Orders.
The frame agreements in the Eldfisk-project are generally made through the FEED phase. The reason for this can be the potential risk of fluctuating prices, delivery time, limited number of suppliers, or specialized and unusual equipment which demands long lead time. Some of these frame agreements are optional for the company to utilize, while other are mandatory and a requirement. The agreements are referred to as Ancillary Agreements.

3.7 Risk

Aker Solutions has through the Eldfisk-project taken on a significant amount of risk connected to the engineering, purchasing and constructional part of the contract. The company is risk averse, and pursues minimizing risk strategy within the purchasing.

The contractual terms towards suppliers is constructed in a way that reduces Aker Solutions risk. The risk can be divided into two groups, one that includes the technical risk (i.e. failure of the product fully installed and running), and the circumstantial risk (i.e. late delivery, engineering problems etc.).

The technical risk is minimized through contractual terms. This means that Aker Solution is not responsible for technical failures due to design errors. To mitigate this there are often supplier representatives when special and critical items are installed at construction site.

The reduction of circumstantial risk in contractual terms is reduced on financial basis. Penalties cost are often used as a tool if supplier does not deliver in time. Close follow up of buyers and engineers ensures that the delivery plan is according to schedule.

3.8 Industry and Package Structure

The equipment packages in the Eldfisk project have a general similarity compared with other EPC projects. The packages are built up emphasizing the supplier market and the necessity to adapt to the industry, so that suppliers can deliver product in an effective way. An example the chapter will further describe a typical mechanical package and its position in the industry.

The procurement process in the project has been described earlier in the text, and leads to one supplier which is awarded a contract. All of the contracts described above, implies that one supplier has the obligation to deliver the product as required. The technical requirements are stated in the *scope of work*, which is a part of the contractual obligations along with the commercial requirements. The scope of work is the technical description of what the project is requesting and describes in detail all technical aspects.

The technical requirements of a typical package in the project are the combination of procurement, design, engineering service, production and assembly. It is rather similar to how the project is built up only the supplier receives a small fragment of the needed items defined and placed in one package that is to be procured form one supplier. The supplier will, similar to the project, have items that need to be procured, after an engineering design. This will also be assembled and in many cases tested by the supplier before delivery, in the same way but a different scale that the company does towards the client (i.e. ConocoPhilips). Figure 3.8-1 shows the breakdown of the contracts from the oil company to the sub-supplier level.

All levels of contracting below the actual project level in the figure has different setup depending on the scope of work. This means that the sup-supplier level does not necessary have all activities that are mentioned.

The structure of the contracting implies that there is a settlement of to what extent Aker is performing detailed engineering. Aker is in many ways adjusting its contracting towards the supplier markets. The variety of package specifications and requirements defines where this limit of work is determined. Some items may have special knowledge requirements and tools that are beyond the expertise of Aker Solutions. This establishes a limit to what Aker can do, and from which point they may need to outsource.

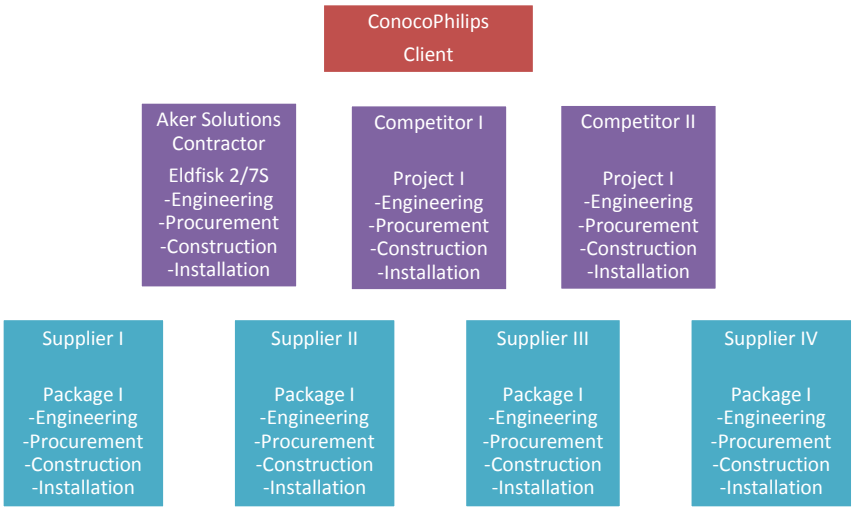


Figure 3.8-1: Market Structure, Source: Author

The package cost drivers would be of interest in case of a vertical integration evaluation for a package. The different activities depend on the individual equipment specifications; some activities are more time and cost consuming than others. The prices requested in a package inquiry in the project are specified; however it can be challenging to have the exact cost for all the activities. The project generally requests cost of the items, where a specified activity cost can be included. A possibility to recognize a highly specified supplier activity/item cost should be used. This would enable the project to perform analyse of the cost related to packages, and later use this to analyse and categorize packages.

3.9 Description Summary

The recent chapter describes structural company specific facts and the Eldfisk 2/7S EPC-project. The intention has been to build a significant decision base for further analysis of the purchases in Aker Solutions in terms of the thesis statements in the assignment.

The company has overall a competitive bidding strategy towards most packages. The client has provided both optional and mandatory frame agreements based on various risk reduction factors. The company is forced through contractual terms to follow such strategy. This implies that Aker Solutions has to develop strategies which does not interfere with future clients' interests in order to meet an enhanced competitive advantage.

This can possibly be done by either vertical integrating, pursue supplier development or new establishment of suppliers to expand number of bidders in the circumstances where number of bidders generates high supplier profit. Even though this could be reducing supplier cost in the project, an expanded number of bidders would often benefit the oil companies in the business, more than Aker Solutions. This depends on the contractual agreements made in the EPC-contract.

Another view of achieving a greater competitive advantage through supplier strategy could be to analyze and recognize the packages that have less supplier dependency, and a scope of work that is a part of Aker Solutions competency. Such packages can be split up to activities that Aker Solutions has the competency to perform and are

able to undertake. This could generate a more effective procurement process but this could also generate more risk for the company.

Aker Solutions has as mentioned initially in the chapter a significant number of offices in typical low cost countries. This is a factor and possibility that should be taken in consideration when establishing future strategies. At this point the absolute majority of suppliers are located in high cost countries, and depending on package activities and future strategies, a possibility is to take advantage of this position. This can be done both in the case of supplier development and vertical integration.

The analysis of the purchasing situation in the Eldfisk-project can be a tool to reveal future possibilities. For the analysis of factors described above it is required to establish a model that can point out specific on the individual packages, the theoretical chapter will therefore focus on the theoretical point of view and models used for such analyses.

4 Method

This chapter describes the methodology used for this master thesis, and the motivation for the choices that are made. Further it describes the variability and reliability of the study, and precautions made to ensure a valid model. According to Yin (2009:8) there are three conditions that should be evaluated when selecting a research method:

- The type of research question
- The extent of control an investigator has over the actual behavioural events
- The degree of focus on contemporary as opposed to historical events

These conditions will through this chapter be discussed in terms of research strategy, observation design, research approach, data collection and research quality.

4.1 Research Strategy

The general form of research is defined by numerous of theorists, one of these are John W. Creswell who states following to explain research.

"Research is a process of steps used to collect and analyse information to increase our understanding of a topic or issue"(Creswell, 2008:8).

Further he describes a model for conducting research as follows.

- Identification of research problem
- Literature review
- Specifying the purpose of research
- Determine specific research questions or hypotheses
- Data collection
- Analysing and interpreting the data
- Reporting and evaluating research

This model represents a general understanding and the overall process of making research. However, within this frame there are several types of researches,

depending on the research topic. The different forms are suited for a variety of different study fields and can be split into in three different forms.

- Explorative – Identify or define a question
- Constructive – Test theories and propose solutions to a problem or question
- Empirical Research – Testing feasibility of a solution using empirical evidence

4.1.1 Explorative

The explorative study is in most cases used for understanding a phenomenon which is undiscovered. The method is in most cases not used for decision making, but rather as a method to answer question regarding why something are in a particular way, or how something work, implicit it does not tell us how many or other quantitative measures. In social studies the explorative research method is often utilized through qualitative approaches. Qualitative and quantitative methods will be discussed later in the chapter. However some has questioned the use of the method and argued for it to be less useful and necessary when other methods can be used (Armstrong, 1970).

4.1.2 Constructive

The constructive method is used mostly towards mathematical and science where the quantitative method is a key factor and typical type studies which utilize the method is computer science. One of the important factors which differ from the other methods is the definitions of measure which needs to be more exact, and corresponds with the utility area.

4.1.3 Empirical

The empirical method, focuses on observation and experience through qualitative or/and quantitative method. The hypothesis in this method which is object to testing should generally be clearly defined. The theory within the study field can be included and compared to the actual case; this will generate an answer to the clearly stated hypothesis of the study.

4.1.4 Selection of Strategy

This single case study is solved through the empirical methodology, i.e. by creating a thesis statement, based on AE & T constant strategy improvement focus, and the interests of the author. The case study research is performed on one of Aker Solutions and AE & T's projects, enabling results to correspond with the established thesis statement.

4.2 Observation Design

The theoretic research methods referred to in the previous chapter has a certain framework or specific method of observing data. The definition creates the premises for how the research strategy is performed. This text will point out the recognition factors within the two main research designs; qualitative and quantitative research.

4.2.1 Quantitative

The quantitative research design is a method used for investigating a subject via mathematical and statistical techniques, mainly used in the constructive and empirical research strategy. It is can be used for testing hypothesis, but also towards the explorative strategy, however this is less common. The typical recognition factors for this research design are:

- High number of data
- High number of range
- Quantifiable results
- Structured interview

The quantitative method is systematized and can be structured in a quantifiable way, and often obtains high data amount. With high structural grading, done in advance, the approach is closed, which shows that we already has decided our observation strategy (Dalland, 2012:167).The information is collected and can be formed into measurable units, which enables statistical analysis. The data collection is often based on a questionnaire or locating statistical data that can be compared. The intention of the method is to collect data enabling an extended understanding of a topic or testing hypothesis.

This assignment includes quantitative research design, with respect to collection of package specific data. Allocating packages into the customized matrix is done through a questionnaire responded by case study personnel. The questionnaire is found in the attachment to this assignment.

4.2.2 Qualitative

The qualitative method differs from the quantitative method, in the way that it is more used to describe a phenomenon with in depth investigation. This method is widely used, especially within social studies without quantifiable factors. The explorative research utilizes the method in particular; however there are many examples of this method in empirical case studies. The method can also be used together with the quantitative method, where this generates a baseline of hypothesis, and the quantitative method tests the actual findings. Typical characteristics of the qualitative method are.

- Low number of research objectives
- Overall understanding
- In-depth investigation
- Unstructured interview

The intention with this method is to generate understanding of all factors and parts of a phenomenon (Dalland, 2012:190). The interview is conducted with an interview guide, and can be done within boundaries, or one a free speaking basis. Some researches demand more guidance from interviewer than others and depend on the subject that is studied.

4.2.3 Design Selection

This master assignment utilizes both qualitative and quantitative methods. The qualitative method is used for establishing risk factors within the company project towards the purchasing in order to customize and validate a portfolio purchasing model. The reason for using the qualitative method in this phase is to obtain information and understand the complexity of the purchasing situation in Aker Solutions Engineering Procurement and Constructional projects. Mason (2002) divides three ways of organizing such data, i.e. category based separation of data, contextual data organizing and use of diagrams and tables. This study utilizes

diagrams and tables for separating, organizing and present the qualitative results. The quantitative method is later used to ensure a correct item allocation in the customized model. This method is chosen because of the big number of packages that needs to be allocated. A qualitative method in the second phase would be too time-consuming for this assignment. Both methods an phases generate the base for arguments and discussion in the result chapter.

4.3 Research Approach

In an argument text the statements and meaning of these can be divided in three types. This depends on how the argument base is constructed; under a quick guide towards the argument build up can be constructed in argument theory.

4.3.1 Deduction

The easiest way of describing this argument method is that it focuses on finding data to support an argument; however it can also be explained more in detail.

The deductive argument is the process of using of widely known and true premises of arguments to achieve a true conclusion. Known hypothesis and proven theory lays the basis for the argumentation, which is opposite compared to the inductive argumentation. A simple example of this type of statements can be.

- All men are mortal
- Socrates is a man
- Therefore, Socrates is mortal

The statements leave no room for interpretation and are considered a fact, which also makes the conclusion a fact. The deduction argument is made upon information that already is consciously and evaluated. Saunders et al (2009) suggests that data collection in a deductive process is characterized by quantitative data, however they do not exclude quantitative method can be utilized. The method has received criticism arguing that deductive arguments do not lead to new knowledge

4.3.2 Induction

The inductive reasoning is to find an argument to explain various data. Inductive reasoning is argument approach which evaluates and constructs statements that are perceptions of other statements as a basis. The inductive argument allows the possibility of the false statement, although the base arguments are true. The argument type is generating a possibility of reasoning upon the base statement. An simple example of this is following argumentation.

- All crows seen by man ever, are black
- Therefore all crows are black

This opens for questioning whether all crows ever are seen by man, if not, the argument can be false. Inductive argumentation can be split up in both strong and weak induction, which depends on the probability of truth. This means that an argument stated inductive, which seems reasonable, can be considered as a strong induction.

One of the biggest critics of inductive reasoning within philosophy comes among others from David Hume. The criticism mainly focuses on the problem concerning the human mind and the use of inductive arguments in decision-making, which in his opinion should be deductive; this is problematized because the human has limited number of experiences, and trouble of evaluating the hypothesis of the uncertain argument.

4.3.3 Abduction

The abduction argument is a combined variant of induction and deduction and is supplying a warrant which enables a move from data to argument. The method can be explained as emphasize on hypothesis, and that this makes the conclusive argument a type of hypothetic explanation of a phenomenon. A simple example of such argument can be; *that if the grass is wet*, this would be no surprise if *it was raining last night*, therefore it would be no surprise that *the grass is wet*. The abduction here is the argument that it was raining last night a reasonable

explanation, which does not have to be true. The advantage of this method is that the researcher does not lock out possibilities, and that the free thinking is emphasized.

En example of these models can be used through the model in figure 4.3-1 by Ellen Di Resta (2007).

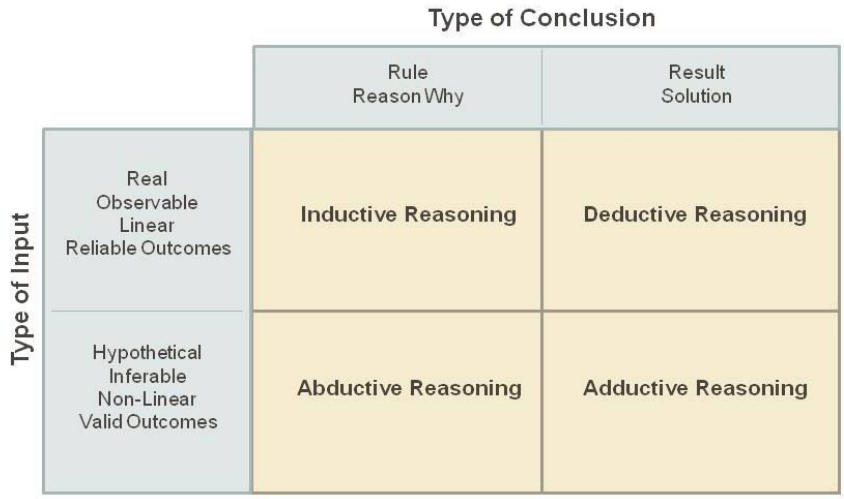


Figure 4.3-1: Reasoning Matrix, Source: Ellen Di Resta (2007)

4.3.4 Argument approach

This thesis utilizes deductive reasoning argue method. The reason for this is the limitations of the case study that is based on described theory which are applied the company. The purpose of the study which not has the intention of creating new theories. The intention of inductive and abductive reasoning is as described to create new theories.

4.4 Data collection method

Data collection in case studies is one of the most important phases in the study. This is the basis of concluding matters and if this does not hold it exposes the entire study for validity and reliability risk. There are several issued that relates to data collection and theory, however some stand out depending on the type of study and research method chosen. A good case study should use as many sources as possible (Yin, 2009:101). The following sections will explain the strengths and weaknesses of the

methods used in this study, i.e. Interviews, documentation, archival records and participant observation, and are based on Yin's (2009) approach to these matters

4.4.1 Interviews

According to Yin (2009) the interviews are considered the most important source of case study information; this argument also applies in this case study. An interviewer has two important tasks during the qualitative interview session. According to Yin (2009) these are a) to follow an interview guide, and b) to ask questions in a neutral way. Both these issues are important and prevent the interviewee to get either leaded to an answer and that the interview gets too structured. The point with the interview is to receive non-biased information, and in some cases maintain a floating conversation. The interview can be performed in several settings; this is referred to as structured, semi-structured and unstructured interviews by Saunders et al (2009), however it is numerous ways of categorize these (Healey 1991; Healey et al, 1993, 1994; Robson, 2002; Powney and Watts, 1987).

The interview was made in two sessions, where second session was based on the first session results. The study performed semi-structured interviews, an interview guide (Attachment 1) was followed to structure the interviews performed. This implies a relatively high structural basis of predetermined questions and structure. The first session focused on letting the respondent speak freely after the question was stated, and the interviewer to use undetermined follow up question based on existing theory to achieve a floating conversation and withhold the case relevance. In the second session the interviewee was asked to range different factors revealed in the first session. The purpose of such interviews has been to generate a basis for expanding and customize the theoretical model which is introduced in the theoretical framework, into a company specific model. By interviewing five key persons with variation in position and field coverage, a model has been customized. The difference in hierarchic position and area of expertise generates a model where several issues have been covered, both from the economic point of view of a leader, but also from the operational point of view of an employee.

According to Yin (2009) the strength in interview is that it focuses directly on the case study topics, and provides perceived causal interferences and explanation. The weaknesses are definitely the bias issue, which can affect questions and answers, but also that the interviewee sometimes answers what the interviewer wants to hear.

4.4.2 Documentation

The documentary information is relevant for almost every case study; it undertakes many forms and should be set into formal data collection plan. It is also a time consuming method with abundance of available material. This type of information includes both quantitative and qualitative data Saunders et al (2009:258). This assignment has used a general set of company specific documents as a basis. Other information sources within the documentary class are the World Wide Web and a variety of theoretic articles, other master assignments and physical literature. The documentation used is either evaluated by the author of this study as relevant, or recommended by project case personnel in Aker Solutions. Some documentation information gathered, especially on the internet, is not always accurate; however it can be helpful even though they not are lacking in bias. The high value of documents should not be underestimated and contradicting findings should be evaluated as clues, which can be object for further investigating. However the over reliance on documents should be evaluated due to the nature of the document, i.e. not intended for the study in the first place. This also implies that this type of data is considered and classified as secondary data.

Yin (2009) points out that the strength of this method is accuracy, broad coverage, stable and not defined for the study. Further he describes the weaknesses as the difficulty to locate the relevant data, which reflects the bias of the author and that it can be deliberately withheld

4.4.3 Participant observation

Participant observation is another collection method which is used in this study, and is described as a method where the collector himself participates in some form or another (Yin, 2009:111). This differs from the other observation method where you are passive towards the study-object. An example of this can be to take become a

resident in a neighbourhood, if the neighbourhood is the case study. Another way of doing this, which refers to this study, is being apart and having a functional role in an organization. The author has been a part-time employee within the project which is studied during the whole period of study. Participant-observation is used very little within management and business, but is not considered useless in this context (Saunders et al, 2009:290). The method has been used in this case-study as a supplementing factor to the interview-method which is emphasized in the case study. The author has only been able to observe a small fraction of the case project, and as one observer this is too small ground for using the method significantly. This results in little use of this method in the study.

Generally and according to Yin (2009) this method has the strength in observing behaviour and motives, context of case and the fact that it covers events in real time. The weaknesses however is that the method is time-consuming, needs many observers, events may be affected by the observing situation and the bias due to participant observer's manipulation of events.

4.5 Reliability and Variability

Because a research design is supposed to represent a logical set of statements, you also can judge the quality of any given design according to certain logical tests (Yin, 2009:40). Within quantitative research, reliability and different validity forms are used as criteria's for quality (Johannessen et al 2011:40). It is important to overall credibility of the study that both validity and reliability are classed as high. This will also open for the study to be used for further knowledge in the topic area.

The literature in general introduces two sets of testing this issue, this study emphasizes on the more common of the two. Yin (2009) describes these as reliability and construct, internal and external validity. The coming sections will discuss these explicitly.

4.5.1 Reliability

The reliability of a study is measured in to what extent a repeated similar study would achieve the same results. This means that the data collection techniques of the

study, and the analysis procedures should have the same result independently of who conducts the study (Saunders et al, 2009:156). High reliability implies that these procedures is followed, which gives the study credibility.

To strengthen the study in terms of reliability it is emphasized on explaining the steps done in the study. All chapters and sections explain the purpose and intention of the content. The analysis chapter has been evaluated as the critical part in terms of reliability; therefore, the chapter description is accentuated. The data collection in terms of the earlier discussed factors, i.e. documentation, interviews, participant-observation is carefully organized and structured. However, as especially the participant-observation section point out, the experience and close connection between the author and organization case creates reliability lowering effect. This increases the risk of less reliability, and is kept in mind while performing the study, and can result in a different result if the study where conducted by others than the author.

4.5.2 Variability

The variability is a measure on whether the findings are what they appear to be (Saunders et al (2009:157). Theorists (Saunders et al 2009; Yin, 2009; Johannessen et al, 2011) recognize the variability as a measure which can be divided in three different sets. Yin describes *Construct Validity* as the first and refers to this as the problem of creating objective measures. Secondly he identifies *Internal Validity* as a test used most in explanatory research, where incorrect relationship concluding and interference can be problematic for validity. The *External Validity* deals with the problem of knowing whether a study's findings are generalizable beyond the intermediate case study (Yin, 2009:43).

To ensure variability in this case study there is done considerations in terms of the key personnel providing the information in terms of the interviews. For establishing a good model, the model theory explicitly recommends the respondents to be from strategic, tactical and operational positions, and with different area of expertise. This has been done and safeguarded through the actual respondents in the interviews, and will therefore strength the variability. Preparations of interview sessions has also

been done in cooperation with the supervisor in the company, which participated in finding qualified and competent personnel for performing interview sessions. The supervisor holds a key strategic position within supply chain and has guided the author regularly in the period of study; this increases the overall variability of the study. Further the internal observations and document guidance has ensured quality of finding relevant information.

4.6 Methodology Summary

This chapter has described the methodology used for this master study. These methods are evaluated with Company and University supervisors together with the author. The methodology chapter is based in particular on theory by Yin (2009), Saunders et al (2009), Johannessen et al (2011) and Dalland (2012).

The study's overall strategy has been to do an empirical case study within Aker Solutions needs and desire. The case uses Eldfisk 2/7S-project, for establishing a valid model and thereby future strategy within supply chain.

For establishing a customized purchasing portfolio model a qualitative interview method is used, the recognition of risk criteria's was emphasized in these interviews. Recommended relevant key personnel were used as respondents in this method. The allocation of purchase items was done through questionnaire with persons responsible for the purchase of these items.

The argue approach used is deductive reasoning due to the utilization of known theory and accepted, and not creating new. Other data collection than interview and questionnaire, document and self-observing methods are practiced by the author.

The variability and reliability is considered by the author as relatively high, due to the careful and structural procedures. However the author has not conducted such studies in the past, which opens for procedure failure and possibilities of misunderstanding to some extent.

5 Vertical integration

The theory of strategic decisions within supply chain management and purchasing has a significant range. It spans from purchasing portfolio models which gives the company a baseline of decision background, to the complexity of agent-principal and transaction costs theory. The overall importance and resource commitment of these decisions is based on companies' willingness and need to practice a cost benefiting overall strategy and the importance of procurement. Many big companies have a culture of addressing this issue in some form, due to the globalization of supplier base and the constant pressure of achieving sustained competitive advantage. The following section of the assignment has the intention of describing the various models and theory which can used to describe, evaluate and create a substantial decision base for answering strategic questions in terms of purchasing strategy. The method in this theoretic summary is based upon broad approach of theory, with the intention to narrow down towards the one major platform of decision making. This platform will be further derived, and used later in the analysis and result part of the assignment. Following theories within vertical integration will be mentioned in general with respect to purchasing.

- Neoclassical Economic Theory
- Agent-Principal Theory
- Resource Based Theory
- Transaction Cost Theory

5.1 Theoretical background of the theories

Vertical integration (VI) is a term that is used for explaining a supply chain, where a company is expanding its ownership or business through fission, joint-venture or similar activities. The term vertical comes from the view of the value chain were the buyers are on the top and the producers are at the bottom. This is also the opposite of the term horizontal integration, which implies firms from the same place in the value chain are merged.

The first person known for actually using what we refer to as VI was Andrew Carnegie. He integrated all suppliers of raw material for his steel firm. The integration

can be made forward to the final stage or backwards to the origin stage of a product or service, respectively the expressions forward integration and backwards integration is used. Among these two main expressions there are others that also are used, such as full, balanced and quasi-integration. The full integration indicates that the whole chain is integrated from top to bottom, i.e. both up and down. The balanced model has the same way of integrating both up and down, but in this case the integration only implies one or two steps. The last and quasi-integration is mostly referred to as a model where join-venture is the base for integrating.

5.2 Theories within Vertical Integration

There are several different theories that can be pertinent to focus on in terms of supplier strategy. Many of the theories can be of relevance because of the interdisciplinary variations which is addressed in procurement of high technical equipment. "*There is no single unified theory of VI that exists today or is likely to exist in the future"* (Joskow, 2006:48). There are numerous interesting theories regarding different approaches to VI. Neoclassical economy, Agent theory, resource based theory's and the biggest which is transaction cost theory will be further discussed in this assignment. The main and emphasized theory in this master in terms of VI remains to be transaction cost based theory within make or buy decisions. The reason for this is the case relevance where the make or buy decision is the main focus in terms of the thesis statement in the previous chapter. Following there will be given a general overview of some theories mentioned that also has its relevance to the assignment topic.

5.3 Neoclassical Approach

This approach focuses on input and output together with prices and all over profits of organizing a company. The theory and pioneers in this economy was Alfred Marshall, which was know a lot for his way of teaching the economy in a simple way for others to understand. The method is evaluating what one could recognize as first glance drivers, i.e. the market situation for the company and how you in best possible and cost reducing way will produce your input to tradable output. Implicit this approach focus more on the external than the internal aspects of the firm and market, although the cost and microeconomic has a big part of this economic theory. Economic

literature in the post-world war II literature shows how strong emphasize that was made on external factors, and that most internal issues was seen on as non-relevant for economists (Joskow, 2006). The issues concerning this method will for sure be an interesting topic. But the assignment would rather focus on other aspects than the neoclassical approach because it seems more of a baseline for all modern economy. In this way it will be included, even though this assignment will not focus on this issue particularly.

5.4 Agent Theory

The principal-agent theory describes the problem evolving when an agent, with compensation acts on behalf of the principal. This problem can be described by an employee can have more knowledge about performing work for an employer, and therefore encounter moral hazards in terms of compensation for performing the work. The employee can be motivated to do the work in a certain way that optimizes the benefit for the employee. This is a theme that can be seen in the light of a supplier relationship that, where the supplier can after receiving an order optimizes his benefit through opportunistic behaviour. This theory has been described by several theorists like Laffont and Martimort (2002). This could also be of an importance for this assignment and issue, in the way of addressing the relationship in the case of joint venture. This theme to the extent it covers this will be described through the theory of vertical integration as it covers opportunistic behaviour in a relationship. However the relevance will not be further discussed in this assignment.

5.5 Resource Based Theory

The resource based theory has another approach which emphasizes on the core competence of the business. The core competence of the business represents the non-imitational skills, and increases the competitive advantage of a company. These skills are difficult to achieve for competing firms, and are important to protect. This makes the resource theory an important view in a sourcing evaluation. Resource based theory in terms of vertical integration are generally derived from Penrose (1959), however, Wernerfeldt(1984) and Barnley (1986, 1981) has also developed

this mind-set. The goal of resource based theory is to generate value to the company through increased competitive advantage compared to the opponents in the market. From a purchasing view this is important to considerate this as a part of the intellectual property in an outsourcing or vertical integration situation. However this will not be further discussed in the assignment.

5.6 Transaction Cost Theory

Transaction cost has been in development from early in 20th century. The theory is related to the cost of doing an exchange. It explains the cost impact that relates to indirect cost of doing an exchange or other activity that supports the exchange of a product or a service. Different types of transaction cost have also been derived in later years, such as Search and Information Costs, Bargaining Costs and Policy and Enforcement Costs (Dahlman, 1979). The first mentioned type could for example be the cost of searching a market for a low price supplier. In such cases one would need to add the cost of the person investigating the market, on the actual purchase itself, to get a view of the actual cost of purchasing an item. In this case the total cost would be both the actual product cost and the transaction cost of purchasing. The theory has several pioneers, where Ronald Coase and Oliver Williamson are the two economists that often are mentioned as the pioneers in transaction cost economic theory.

One of the persons that first introduced the transaction cost as a way of thinking was the economist John R. Commons. He was one of the institutional economists of the early 20th century, and discussed this type of costs in his review *Institutional Economics* in 1931. However Commons is known for his work in institutional economics, and not transaction cost economics.

The transaction cost theory was discussed, however not mentioned, by Ronald Coase in his book *The Nature of the Firm (1937)*. The book points out the behavioural fact of firms creating departments, instead of buying the service or products in the market which would have been the most economic if one could neglect transaction cost. However, it takes 23 years before he refers to it as Cost of Market Transactions (Coase, 1960). The term Transaction Costs itself can instead

be traced back to the monetary economics literature of the 1950s, and does not appear to have been consciously discussed by any particular individual (Kissell, Glantz, 2003).

The transaction cost economics (TCE) has as mentioned been discussed by the above mentioned economists, but in the last decades it has been Oliver E. Williamson that has contributed the most to this topic. Williamson was one of Coase's students and are specialized within transaction cost, and has also in his work been influential in discussions concerning boundaries between public and private sectors.

5.6.1 Theory and Determinants of TCE

Williamson arguing supports the facts that the incentives to vertical integrate increases as the transaction costs gets higher and higher. Further Williamson (1985) argues for three types of transaction costs. Negotiation cost which occurs as a result of negotiations between the parties in the transaction. Surveillance cost is arising because of the need to control and ensure the transaction which is being done, and cost is rising as transactions can be time consuming. Adjustment cost can be explained by the cost of non-effectiveness by the parties to adjust to each other. One could say that as the administrational cost of purchasing are increasing, the profit premium of the suppliers are also increasing, which again will support this theory. Williamson (1979; 1985; 1991) argues for certain determinants of transaction costs which can be divided into behavioural assumptions and governance problems. In terms of the behavioural assumptions we find limited rationality, risk neutrality and opportunistic behaviour.

Behavioural

Limited rationality seems to explain the problems encountered when the parties of a transaction have difficulties to see the cost associated with future and unknown environments. These are difficult to pick up before an exchange, because there can be change in the parties preferences, external changes or contractual uncertainties. Further the contractual uncertainties will be present as a result of cognitive differences in understanding of the exchange. One could in this way say that all contracts are in some way incomplete (Williamson, 1999).
Opportunism in TCE is dealt with from a behavioural point of view, with focus on actions by the parties. The other way of seeing it, from an attitude standpoint will not

be discussed in this assignment. This is because the actual actions are the most relevant case, since this assignment sees things from practical perspective. Examples of this behaviour can be dishonesty, steeling, fraud or disloyalty. Opportunism in this case is focused on the parties' strategic choices and moral preferences based on their own interests (Williamson, 1985).
The last behavioural determinant argued by Williamson is risk neutrality. This determinant is different from the other behavioural factors because this theory focuses on the actual properties of the theory, and not the parties' attitude towards risk (Williamson, 1985). Risk neutrality in TCE theory has not been subject for many empirical studies (Rindfleisch & Heide, 1997). Some have tried to define this, though not in terms of Williamsons view, like Chiles & McMackin (1996) defines:

*"An assumption of risk neutrality suggests that a risk-neutral party is "indifferent between a prospect of uncertain profit, provided that the expected average of the prospective fluctuating profits is equal to the certain profit"(Aoki, 1984:15). These parties therefore have a linear utility function (Townsend,1982), which is characterized by constant marginal utility."(*Chiles & McMackin, 1996:81).

Governance

The governance problems are asset specificity, environmental uncertainty and frequency. These problems occur as a result of the behavioural assumptions mentioned above, and can be identified as the safeguarding problem, the adaptation problem, and the performance evaluation problem (Rindfleisch & Heide, 1997) respectively.

Asset specificity is defined as "the degree to which an asset can be redeployed to alternative uses and by alternative users without sacrifice of productive value" (Williamson, 1991a:281). Williamson(1985) identifies six different types of asset specificities which he refers to as "durable investments that are undertaken in support of particular transactions, the opportunity cost of which is much lower in best alternative uses or by alternative users, should the transaction be prematurely terminated". The different type of specificities he distinguishes is site brand name capital, human asset specificity, site specificity, physical asset specificity, dedicated assets and temporal specificity. As the wording explains the different types are a way

of identify investment cost, such as for example site specificity which can be the investment cost of sharing warehouse etc. The safeguarding problem arises for one party as a result of the unknown factors and possibility of opportunism in the counterparty.

The uncertainty has is weakness in the rationality on the behavioural side and the adaptation problem on the more operational side. This uncertainty can also be divided into both behavioural and environmental. According to TCE the environmental uncertainty leads to problems of making complete contracts, which specifies future and unknown issues (Williamson, 1991a). The behavioural uncertainty is also linked to opportunism, which can cause problem in contractual issues. In this way one could interpret this to mean that the uncertainty is a driver for VI, because this will remove the object of uncertainty.

The last dimension is the transaction frequency. Williamson (1979) split this up in three factors which determine how often the transaction is made. In this case one could argue for the VI to take place, the more often one do the transaction. In this way it would be easier to justify the cost of integrating. The frequency will be discussed in later chapters concerning typical transactions in Aker Solutions EPC projects.

5.6.2 New literature

Most Make-or-buy theory emphasizes in TCE-reasoning when performing the analysis. There are a large number of empirical researches made in the area of concern (Peter G. Klein, 2004:438). He mentions that most of these have focused on the typical TCE assumptions such as frequency, uncertainty and asset specificity, and that they are independent variables and that asset specificity has received the most attention in empirical studies. In these studies there have been done empirical studies on the technical aspects of asset specificity, these have been issue for different types of technical specifications.

Peter G. Klein (2004) also mentions that to procure items on an open market, or produce them in-house, was one of the first topics that has been studied within transaction cost theory. Monteverde and Teece (1982), and Masten (1984) found a

significant relationship between asset specificity and VI. That asset specificity was the predictor of VI was made through analysis based on defining items as bought or self-produced, type of specificity, and recognizing complexity.

Further studies inside companies have been made to establish theories of which are highly relevant to this study. Walker and Weber (1984) found in their study that the uncertainty of production volume increased the possibility of in-house production. The same study also however showed that there was no connection between technologic uncertainty and in-sourcing. The technologic uncertainty was measured after the frequency of change in specification. Another study which was focusing on human capital, found that the engineering effort (i.e. the human asset specificity) tends to affect the decision of integrating or not more than the site specificity (Masten et al, 1989). "*Many recent studies of single-industry cases show that there is very strong relationship between the human capital asset and the use of VI, there has also been done cross-industry studies, however, these has been subject for some criticism*" (Peter G.Klein, 2004:443).

Another factor that is well addressed in the make-or-buy-theory and that should be taken in consideration is the contractual awareness that should be present. As earlier mentioned in this assignment several problems can occur related to incomplete contacts. Crocker and Reynolds (1993) investigate Air Force procurement and finds relationship between suppliers that have history of disputes with purchasers and contract completeness. The ones that had history of disputes had a greater completeness in terms of the contract than the suppliers that had high technologic uncertainty. This issue should be met to reduce future cost for companies analysing their transaction cost. Klein (2004:447) discusses other studies that give reason to believe in a relationship between contract duration and cost of contracting. This implies that short term contracts gives high uncertainty, and vice versa.
The theory of make-or-buy decisions with focus on international outsourcing seems more limited than other the other topics such as described earlier in the chapter. However there are some references by Rosanna Nisticò (2004:16) on this issue. She referrers to a model by Antras (2003) which has been object for further analysis. Antras(2003) uses a study with focus on Grossman and Hart's (1986) view on

property rights, and combine this with Helpman-Krugman's (1985) model of international trade.

Antràs (2003) shows that conferring to the latter the residual rights of control may not suffice to induce suppliers to undertake adequate levels of investment. When this is the case, final good producers will find it optimal to alleviate the underinvestment of their usual suppliers, due to the fear of incurring hold up problems, by contributing to their relationship-specific investments. The investment sharing, however, if it reduces the risk of hold up faced by suppliers, correspondently increases the risk faced by final good producers (Nisticò, 2004:16).

Nisticò (2004) also refers to a study by Antras and Helpman (2004), they focus on relationship and outsourcing between two firms. The firms have different location specifications such as wages and are referred to as South and North. The North firm is representing the high cost level and the south is representing the low cost (i.e. high wages in North and low wages in the South). This study shows a certain relationship between two firms of this nature, which is a very typical set up for many firms evaluating VI. It indicates that a low cost firm would not integrate, due to the fact that the outsourcing would generate lower organizational cost than VI. However this will be depending on the wages and cost level of the organization. The study is in the same way supportive that firms from high cost counties would have incentives to integrate in low cost countries.

Further on this issue was also Antras (2005) study on the same issues, however related to contractual completeness, but still related to north and south view from the year before. The study focuses on the issues related to internationalization of *product cycle hypothesis* (Vernoon, 1966). This cycle-model is referred to as a model explaining movement of production places with emphasis on the life-cycle of the product. However, Antras's (2005) model explains these issues from a TCE and a contractual point of view, showing that a product is better of having a safe start, implicit meaning that the production place in the development phase should be located where contractual difficulties and uncertainty is less than if the product is in the maturity stage. This means that the production at first is best of within the high wages and cost area in north, and later moved to south with more contractual

uncertainty and lower costs. Furthermore he discusses that this will at first give the firm possibility to move production to a low cost area, and outsource later when the product are in an advanced development stage. In this way the contractual issues are allowed to increase as the product is developed. Antras (2005) is in this way weighting the degree of contractual incompleteness up against the benefit of producing at a lower cost and with lower wages. On the contrary, the benefit from lower wages will be greater than the benefit from incomplete contracts; the actual location would be south. In this way one could say that if the benefit from low wages is high enough, the best place to locate production would be south.

6 Purchasing Portfolio Models

Further the assignment will emphasize on one main theoretic base for evaluations regarding analysing the overall purchasing strategy. This theoretic approach is Purchasing Portfolio Model. Because of the large extent of the theoretical directions related to purchasing and material supply management, this theoretical chapter is limited. The intention of this has been to keep a steady course towards further analysis where consistency is needed.

This chapter will give a general introduction to purchasing portfolio models originating from Peter Kraljic's (1983) matrix, which is used by many companies in several different businesses. The portfolio models are constructed to distinguish specifics of the supplier base in the companies using them. A portfolio model enables the companies to create a tool for selecting future strategies both in the short and the long run. The origin of Peter Kraljic's purchasing model comes from theory by the Nobel-awarded economist Harry Markowitz (1952), which conceptualized the basis for such a model, for use on his capital investments. In later time there has been established several models with the intention of controlling purchasing. The chapter explains the general outline of the different models and how they are used in practice, along with a view of how the different strategies are applied in each model.

The theory of portfolio models in this chapter will emphasize on the ones that are originating from the most known purchasing portfolio, which is Peter Kraljic's (1983) matrix. Other models such as Activity Based Costing (ABC)-method and industrial network approach (Dubois and Pedersen, 2002) which could be interest are not considered or further discussed in this assignment. The chapter will summarize with facts evaluated regarding selection of actual model for further analysis, and a short discussion of criticism that has been aimed at these models.

6.1 Kraljic Matrix

The Kraljic matrix was first introduced in the article "Purchasing must become supply management" (Kraljic, 1983), and has since it was introduced been a major influence on supply management. The purpose of the matrix is to generate an overview of purchasing goods and their supplier markets. In practice this is a four stage model

which consists of following phases; classification, market analysis, strategic positioning and action plans. These phases will be further described.

6.1.1 Phase 1

The classification phase is the first of the four phases, and the one that defines how the purchasing is analysed. The procedure for doing this is divided into two sub-categories of *supply risk* and *profit impact*. *"The profit impact of a given supply item can be defined in terms of the volume purchased, percentage of total purchase cost, or impact on product quality or business growth. Supply risk is assessed in terms of availability, number of suppliers, competitive demand, make-or-buy opportunities, and storage risks and substitution possibilities"* (Kraljic, 1983:112). These criteria's are the major influence and basics that allocates the purchasing groups or items, and thereafter classifies them, throughout the analysis. After identifying the category criteria's the matrix is divided in four different categories which has its own specific name and characteristics in terms of strategic theory.

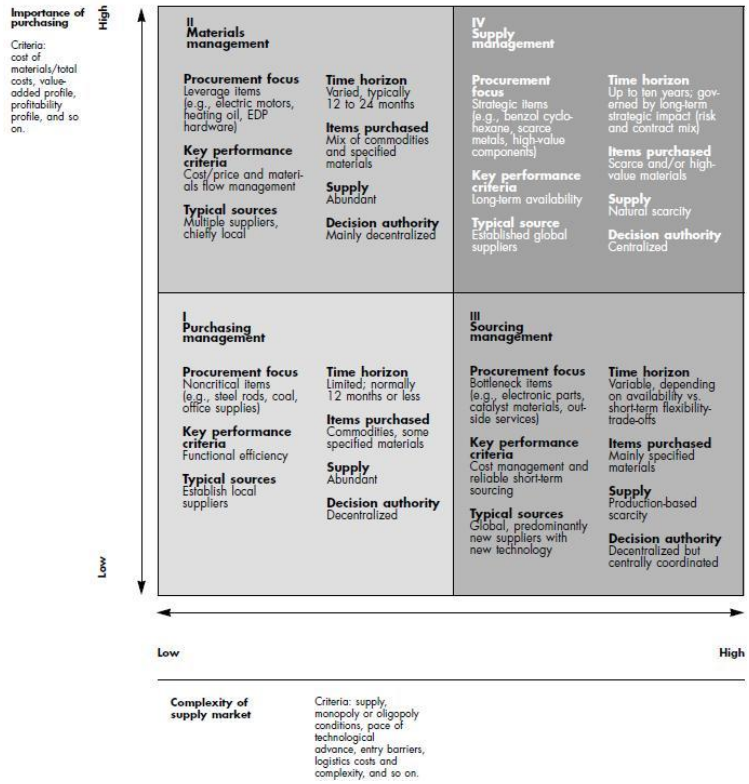


Figure 6.1-1: Kraljic Matrix, Source: Kraljic, 1983

The square referred to as *strategic items (IV)*, which implies high supply risk and high profit impact. The square under is *bottleneck items (III)*, which has characteristics of high supply risk, but on the contrary low profit impact. The *leverage (II)* area is

defined as high profit and low supply risk, and the last one, *non-critical (I)* implies low on both profit and supply risk. This categorization is seen in the figure from "Purchasing Must Become Supply Management" (Kraljic, 1983) below.

According to Kraljic (1983) all different categories demand different approaches depending on the company using them and their strategic implications throughout the market. As the figure over points out, there are different decision levels of decentralized and centralized authority, accordingly in his article, he point out the strategic levels of each category. The decision level of strategic items is recommended on the long term and top level, due to the criticality of such items. Further the *bottleneck* and *leverage items*, as well as *non-critical items* are distributed to tactical and operational levels respectively. The importance of decisions will influence the further use of tools, which may need to be included for each category. Companies can use market analysing tools such as risk analyses, simulations, optimization models and price forecasting techniques to consider the different strategies in each category.

6.1.2 Phase 2

The next phase of Kraljic's model is market analysis. This phase emphasize on the relationship between the supplier and the company performing the analysis. The bargaining power of the supplier for each item is weighted against the companies. Kraljic (1983) points out a list which will by reasoning give characteristics of supplier market versus the companies own strength. According to Kraljic (1983) the criteria's listed in table 6.1-1, should be used to classify the items in each category. However he also points out that the list has to be applied and customized to fit each industry. The factor of importance to each criterion is also a consideration that should be considered, as well as the need for a correct analysis of the conditions. This analysis generates a more awareness in terms of the company's power or powerless situation towards the supplier.

Table 6.1-1: Purchasing Portfolio Evaluation Criteria, Source: Kraljic 1983

Purchasing Portfolio Evaluation Criteria	
Supplier Strength	**Company Strength**
Market size versus supplier capacity	Purchasing volume versus capacity of main units
Market growth versus capacity growth	Demand growth versus capacity growth

Capacity utilization or bottleneck risk	Capacity utilization of main units
Competitive structure	Market share vis-à-vis main competition
ROI and/or ROC	Profitability of main end products
Cost and price structure	Cost and price structure
Break-even stability	Cost of non-delivery
Uniqueness of product and technological stability	Own production capability or integration depth
Entry barrier (capital and know-how requirements)	Entry cost for new sources versus cost for own production
Logistics situation	Logistics

6.1.3 Phase 3

The following phase in Kraljic's (1983) model is to position the items from the first phase into the model in figure 6.1-2. The matrix for this phase generates a relationship between company strength and supply market strength, and classifies the situation for each item as;

- Diversified
- Exploited
- Balanced

This will generate individual positioning, which again will be used to identify risks and opportunities for each evaluated item. Identifying this will allow the company to make basic strategic plans for the items positioned in the matrix. A situation describing the *exploited* category is when the company through this phase and criteria evaluation has a strong position in a market and the supplier has low strength. In a situation like this the company has the strength to exploit their market position and carry out aggressive negotiations, to establish good conditions and prices. The supplier would most likely because of their weak position accept poor conditions, due to the

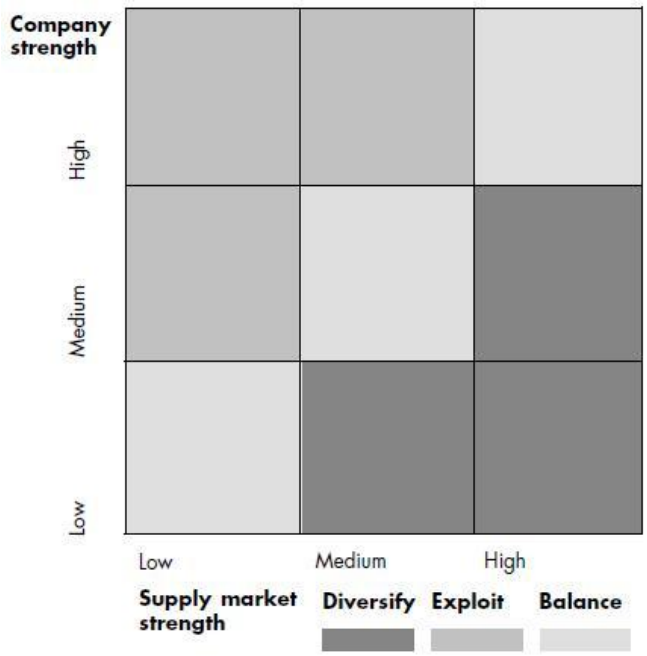


Figure 6.1-2: Supply Market and Company Stregth, Source: Kraljic 1983

strength relationship. On the other hand, the opposite would be a weak position for the company, which in this case the supplier would be the exploiting side, and force the company to carry out a less aggressive approach. This case would categorize the relationship to a diversify-quadrant. The balanced relationship is neither of the other and the strategy for this classification is a balanced appearance towards suppliers to ensure further and trustworthy cooperation.

6.1.4 Phase 4

The last phase described by Kraljic (1983) is dedicated to the establishment of further action plans based on the earlier phase findings. The three strategic clusters from phase 3, has each its individual strategies which now can be considered, in terms of volume, price, supplier selection, material substitution, inventory policy among others. The actual position of each item also needs to be considered with respect to both long and short term future. This phase gives the company possibilities to consider all analysis facts and create counteractions and actions to mitigate the future supply chain strategy. *The end product will be a set of systematically documented strategies for critical purchasing materials that specify the timing of and criteria for future action* (Kraljic, 1983).

6.2 Models based on Kraljic's

In recent years after Kraljic's model was published the purchasing portfolio model theory has received a significant amount of attention by both in the academic and business environment of purchasing. Together will this attention there has also been fronted critique towards such models. This chapter will give a short introduction to the most used and discussed models originated from Kraljic's matrix. Even though there are related models by Elliott-Shircore and Steele (1985), Hadeler and Evans (1994), Van Stekelenborg and Kornelius (1994), Lilliecreutz and Ydreskog (1999), Håkansson and Persson, (2006), this assignment will not discuss or address these models. Following authors has published models which will be further described to generate a theoretical base for selection of the most relevant model.

- Olsen and Ellram (1997)
- Van Weele (2002)

Olsen and Ellram's (1997) model are discussing the importance of weighting of the criteria's in Kraljic's modell, since this is the major influence for positioning the items and are laying the ground for further action plans. Van Weele's (2002) model is a

one-by-one model, which means that it uses Kraljic (1983) matrix, but with one criterion for each dimension (i.e. different from Kraljic).

6.2.1 Olsen and Ellram – A model based on weighting and supplier relations

This purchasing model introduces an important issue that Kraljic's matrix did not, and therefore receives some critique in the literature. The fact that buyer and supplier have an interdependent relationship is taken into consideration in Olsen and Ellram's (1997) model. Because of these considerations, this model is also an important contributor to the purchasing portfolio model theory. The model is with other words a modification from the Kraljic (1983) model, with its extra dimensions of supplier relations. The model has the same build up as Kraljic, however it describes three and not four phases.

Step 1 – Analysis of the company's purchases

The classification method is similar to Kraljic; however the dimensions are identified as *strategic importance of the purchase situation* and *difficulty of managing the purchasing*, meaning the same categorization as Kraljic. The criteria's for the categories is listed in table 6.2-1.

Table 6.2-1: Kraljic Matrix Factors, Source: Kraljic 1983

Factors Influencing the Strategic Importance of the Purchase	**Factors Describing the Difficulty of Managing the Purchase Situation**
Competence factors 1. The extent to which the purchase is a part of the firm's core competencies 2. Purchase improves knowledge of the buying organization 3. Purchase improves technological strength of buying organization Economic factors 1. Volume or dollar value of purchases 2. The extent to which the purchase is a part of a final product with a great value added 3. The extent to which the purchase is a part of a product with good profitability 4. Criticality of the purchase to get leverage	Product characteristics 1. Novelty 2. Complexity Supply market characteristics 1. Suppliers' power 2. Suppliers' technical and commercial competence Environmental characteristics 1. Risk 2. Uncertainty

with the supplier for other buy's Image factors 1. Supplier critical image/brand name 2. Potential environmental/safety concerns	

Concerning the *Strategic Importance of the Purchase*, the competence factors to what extent the item bought is a part of the core competence of the business or not. *The closer an issue to the core competencies of the firm, the greater the strategic importance of the item purchased* (Olsen and Ellram, 1997:104). The economic factors are describing the value of the actual purchase and its profit added and value to the company. The image factor off course considers the building image of purchasing the good.

The factors describing the *Difficulty of Managing the Purchase Situation* are divided into three sub-factors of product, supply market and environmental characteristics. Her more product specific facts are evaluated like product maturity, complexity, the power of supplier and their competency, as well as the environmental risk.
In the same way as Kraljic (1983), Olsen and Ellram(1997) point out the importance of customization towards each company and industry.

When the criteria's is decided Olsen and Ellram (1997) introduce the importance of weighting of the criteria's of each factor which enables each good a position in the matrix. To ensure that the quality of such measure's they also include a weighting system in their article. This weighting method is derived by Narasimhans (1983), and is applied to Olsen and Ellram's methodology.

Narasimhans (1983) method is based on simple mathematics that safeguards each weighting subject according to a model hierarchy of the criteria's. This weighting method is done in both dimensions of the factors and gives out a value of weight that corresponds with the entire model. The limitations of the model are that the initial weighting needs to be predetermined. In the figure 6.2-1, the weighting hierarchy of the model is shown with formulas from Narasimhans(1983).

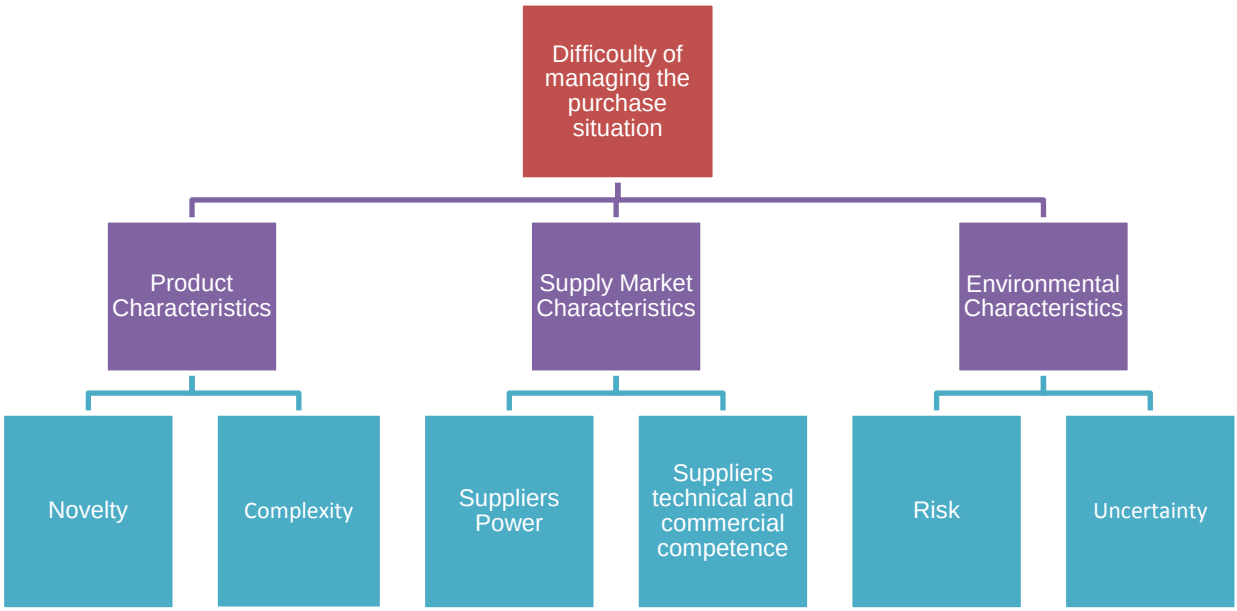


Figure 6.2-1: Factor Hierarchic Model, Source: Narisimhan 1983

The formulas for calculating the weights are showed below. This system is based on one-to-one evaluation of the different factors in the model. The model is used later in the thesis while establishing the weight of the customized and company specific model.

Table 6.2-2: Narisimhan weigthing table, Source: Narisimhan 1983

	F_1	F_2	....	F_n	S	W
F_1	X_{11}	X_{12}	....	X_{1n}	Z_1	W_1
F_2	X_{21}	X_{22}	....	X_{2n}	Z_2	W_2
....	....	....	....	....	....	....
F_n	X_{n1}	X_{n2}		X_{nn}	Z_n	W_n
				Sum	**S**	**1.0**

Table 6.2-3: Narsimhan weighting method, Source: Narisimhan 1983

n	The number of factors
f_n	A factor
X_{ij}	The result of an evaluation of factor i's importance compared to factor j's importance using a scale from 1 (equally importance) to 9 (absolute importance). If factor i is less important than factor j, x_{ij} is evaluated instead. The matrix is completed by using the equation: $x_{ij} = 1/x_{ij}$
Z_i	The geometric mean of row number i: $Z_i = \sqrt[n]{x_{i1} \cdot x_{i2} \cdot \ldots \ldots \cdot x_{in}}$
S	The sum of geometric mean: $S = \sum_{f=1}^{n} Z_f$
W_i	The weight of factor i: $W_i = Z_f / S$

As the model shows, every factor is given a weight W_n, which states the value of each factor in the model, his ensures logic weighting. These weights are further based on a point system for evaluation of each factor. Olsen and Ellram (1997) proposes a nine-grade scale in their article, however this is not final, and can be customised based on the criteria's set by company using the evaluation model. The Narsimhans (1983) weighting method will then give you the coordinates to be used in the matrix which is similar to Kraljic's (1983) model.

Step 2 – Analyse the Supplier Relationships

For the analysis of supplier relationships a new matrix, i.e. different from Kraljic's (1983) matrix of supplier versus company power, is introduced. Olsen and Ellram (1997) refer to the rapid change of supply markets when criticizing Kraljic's recommendation to use a strong position, and introduce exploit strategy against suppliers. Instead Olsen and Ellram (1997) suggest and recommend that *relative supplier relationships* have influence on how the strategies are developed, which then adds a dimension more than Kraljic. By adding this dimension it is introduced a list of many aspects taken into considerations by companies as they select their supplier. Also this list is not comprehensive and the criteria's should be customized, both in weight and relevance, for the company's own industry. Adding or removing evaluation factors will influence on the completeness of the analysis.

Table 6.2-4: Factors influencing anf sescribing relationships between the supplier and buyer, Source: Olsen and Ellram 1997

Factors Influencing the Relative Supplier Attractiveness	Factors Describing the Strength of the Relationship
Financial and economic factors	Economic factors
1. The supplier's margins	1. Volume or dollar value of purchases
2. The supplier's financial stability	2. Importance of the buyer to the supplier
3. The supplier's scale and experience	3. Exit costs
4. Barriers to the supplier's entry and exit	Character of the exchange relationship
5. Slack	1. Types of exchange
Performance factors	2. Level and number of personal contacts
1. Delivery	3. Number of other partners
2. Quality	4. Duration of the exchange relationship
3. Price	Cooperation between buyer and supplier
Technological factors	1. Cooperation in development
1. The ability to cope with changes in technology	2. Technical cooperation
2. The types and depth of supplier's current and future technological capabilities	3. Integration of management
3. The supplier's current and future capacity utilization	Distance between the buyer and supplier
4. The supplier's design capabilities	1. Social distance
	2. Culutal distance

5. The supplier's speed in development 6. The supplier's patent protection Organizational, cultural, and strategic factors 1. Influence on the company's network position 2. The internal and external integration of the supplier 3. The strategic fit between buyer and supplier 4. Management attitude/outlook for the future 5. Top management capability 6. Compatibility across levels and functions of buyer and supplier firm 7. General risk and uncertainty of dealing with the supplier Other factors 1. Ability to cope with changes in the environment 2. Safety record of the supplier	3. Technological disctance 4. Time distance 5. Geographic distance

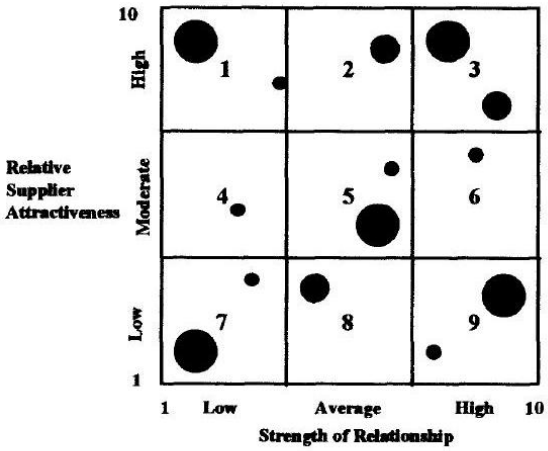


FIGURE 2. Analysis of supplier relationships.

Figure 6.2-2: 3 Dimensional Matrix, Source: Olsen and Ellram 1997

Together with the supplier attractiveness list Olsen and Ellram (1997) also has criteria's for the Strength of the Relationship between suppliers and company, similar to Kraljic (1983). As showed in figure 6.2-2 the resource allocation (i.e. the new dimension different from Kraljic (1983)) towards the supplier is expressed by circular size differences. Big circles are symbolizing the suppliers with strong relationship with significant resource allocation, while the suppliers with less connection represent the opposite. The model is in fact considering three dimensions (strength of relationship, supplier attractiveness and resource allocation) for further use in the next step, which is establishment of action plans.

Step 3 – Action plans

This phase emphasize on establishing the future strategic plan for the supply base, based on the company's purchases and suggested strategy in step 1, and the supplier relationships analysed in step 2. The basic for developing these plans are the matrix of resource allocation, supplier attractiveness and relationship strength. The matrix is divided similar to Kraljic (1983) power matrix, i.e. 9 different squares,

with both axes consisting of high, medium and low score. Olsen and Ellram (1997) divide the 9 squares into three general groups of action plan basis.

- Cell 1, 2 and 4 – High or moderate supplier attractiveness with low or average relationship strength.
- Cell 3, 5 and 6 – High or moderate supplier attractiveness with relatively strong relationship strength.
- Cell 7, 8 and 9 – Low supplier attractiveness with high, medium and strong relationship strength.

Each of these will be given three different plans depending on the step 1 analysis results. The first action plan basis (cell 1, 2 and 3) is considered important due to desirable attractiveness. Olsen and Ellram (1997) argues for strengthen of the supplier loyalty, if the analysis in part 1 describes the purchase as strategic. For Non-critical purchases they imply strengthen relationship without allocating resources, for example through volume increase.
Next plan basis (cell 3, 5 and 6) the importance of maintaining the strong relationships, by reallocating among different activities. There are less concern about the analysis in part 1, and the plan covers most purchases regardless of position.
The last action plan basis (cell 7, 8 and 9) is the only one that Olsen and Ellram (1997) pursue change of supplier argumentation. However they discuss importance of reconsideration due to some supplier's effect on network positions.
Problems connected to this are identified by Olsen and Ellram (1997) as significant resource use, which can be too comprehensive in terms of resources. The solution for this problem, is according to Olsen and Ellram (1997) prioritising the action plan based on strategic importance.

6.2.2 Criticism of purchasing portfolio models

Following section is a summary of critiques within purchasing portfolio model theory by Van Weele and Gelderman (2005, 2003). The articles both points out criticism from the theoretic and business perspective, which following text represents.

One of the major critiques is based on the simplification process which is necessary for the model to be constructed. The fact that future strategy and action plans is based on a two-dimensional model, is far to simplified many claim. Dubois and Pedersen (2002) criticize the model for not including complex aspects of supplier-buyer relationships and ignoring context of networks, and to avoid supplier power situations. In the same way the model misses the interdependencies between products (Ritter, 2000), and the relationships between firms to enhance competitive advantage (Wagner and Johnson, 2004).

As mentioned earlier in the text, Olsen and Ellram (1997) find the power exploiting strategy fronted by Kraljic (1983) dangerous because the rapid change in industries, and that the weighting issue is crucial for the methodology to hold. Nellore and Söderquist (2000) is also criticizing the weighing issue. From another point of view Cox (1997) actually condemns the methodology by claiming that it removes the possibility to be proactive towards future power relationships.

Van Weele and Gelderman (2005) approach the use of portfolio models and to what extent the methodology is reliable in decision making. *Findings indicate that portfolio usage is definitely a sign of purchasing sophistication* (Van Weele and Gelderman, 2005:19).
Kraljic's (1983) matrix has received most of the critique, which seems reasonable since he introduced the model. The later models which has a great deal of similarities with Kraljic, has tried to apply what Kraljic seems to have missed, however there are still problems that needs safeguarding.
The theory has little coverage of how these models are used in practice, and the next section will through Van Weele and Gelderman (2003) clarify the use of these, from a practical point of view.

6.2.3 Practical approach of purchasing portfolio models

This text introduces the portfolio modelling from a more practical viewpoint and how it is applied to practical business cases. The text is summarizing Van Weele and Gelderman's (2003) case study article, where the models are applied three different companies with three different characteristics and purchasing base.

The three companies investigated are DSM, Akzo Nobel Coatings and Te Strake, which are into industries of science nutrition, coatings and advanced modules respectively. The companies where selected in such way that one could evaluate and observe the different approaches to portfolio model. For investigating the corporate level DSM was chosen, and the focus where *synergy* and *leverage* across business units, and is viewed as a tool to for decision making, in terms of for instance joint-operations. The second case study of Akzo Nobel addresses the raw-materials procured by sub-business units across several of their hubs. The last study of Te Strake is similar to the first study done at business level, the specifics of this company is that they have a fairly limited number of suppliers, due to their high technical level.

Use of the model

The model is as earlier mentioned open for customization, which means that the model needs to be adjusted and tailored for each company. The model requires multi discipline teamwork, and specialists from different parts of the organization. In this way the model will be affected by many disciplines across the company, which is crucial as a purchase is not a one factor evaluation. Table 4.6-6 shows some of the characteristics of the different approaches performed in the case studies, their measurement and use issues.

Even though the model is an interpretation of the company who utilize it, there are a range of questions that needs to be answered regarding the positioning in the matrix. The result needs to be reflected upon, and in-dept discussions on the positions are considered the most important things, as this leads to more consensus-based decisions. Questions that are object for the discussion based evaluation are quoted directly from Van Weele and Gelderman (2003:210).

- *Why is an item/product positioned in this specific spot?*
- *Are the found positions in line with previous expectations?*
- *Are positions, unintentionally and wrongfully, influenced by the measurement method?*
- *Are therefore readjustments necessary?*
- *How should one view and assess the found positions?*
- *What is the interpretation of the results?*

- *Where are points of intervention? Which risks are (un)acceptable?*

These questions lead to further issues that companies needs to answer in terms of the measurement issue. The actual positioning can be performed according to Van Weele and Gelderman (2003) and the case studies in three different ways.

- Consensus method (used by DSM)
- One-by-one method (used by Akzo Nobel Coatings)
- Weighted factor score method (used by Te Strake)

Table 6.2-5: Reference companies in study, Source: Gelderman and Van Weele 2003

Use and measurement issues	DSM	Akzo Nobel Coatings	Te Strake
Frequency, occasion	Irregularly, in response to changes	Regularly, fully integrated with daily practice	Incidentally, on major customer level
Main Advocate and project manager	Director purchasing services	Purchasing vice president of each business unit	Strategic buyer of the business unit
Main purpose	To identify and to develop synergy and leverange across business unit	To detect and to cope with supplier dependence	To assess risk and identify possibilities
Method	Consensus method	One-by-one method	Weighted factors score method
Dimensions	-Strategic importance -Supply risk	-Value of purchases -Number of suppliers	-Profit impact -Supply risk
Determination of factors	During the analysis, basically unlimited	In advance, factor are dimensions	In advance, limited number
Measurements of factors	Consensus based	Objectively	Consensus based
Determination of weights	Implicitly, during the analysis	NA	Explicitly, in advance
Aggregation of sub scores	Consensus based	NA	Arithmetic (additive model)
Demarcation	Consensus based	Objectively: *The upper half of the matrix contains all items that add up to 80% of the total purchased value *3 or more available suppliers is a low supply risk	The midpoints of the two constructed scales

The *consensus* method is based on finding positions for the items purchased by use of discussion and reasoning. The discussions is based on views supported by facts, and is considered a flexible method, however it is pointed out the importance of the method requires a consensus over the results. The *one-by-one* method however uses an oversimplification of the matrix, by only using one key factor for each dimension in the matrix. The method enables the company to observe the key critical factors, removes the weighting issue (Olsen and Ellram, 1997), and does not require complex information. However this method is has limitations in terms of the *one* key factor. The last method, i.e. *weighted factor score* method, is generating a more complex view. Here the user is required to perform significant reasoning over the weighting system and factors. The important issue in this method is to recognize that "*a lower score on a factor can be compensated by a high score on another factor"* (Van Weele and Gelderman, 2003:211). Another implication is less overview and the need for data that can be hard to find in many information data bases.

The decision of method can be difficult, but a number of criteria's from the Van Weele and Gelderman (2003) is listed to determine the method:

- *The required objectiveness (high?, then 1-to-1),*
- *Number of key factors (high?, then consensus or weighted factors),*
- *Available time ('no' time?, then consensus or 1-to-1).*
- *Needed customization and flexibility (high?, then weighted factors).*

Strategic directions

The cases investigated by the authors of the article, all had additional information regarding the overall business strategy, the situation of supply markets, performance capacity and intentions of suppliers.

The strategies in the study was all on item level, however it is possible to also perform the model in terms of category and matrix level. For instance it is given examples where one could pursue the strategy of emptying one of the four categories, or reduce/increase the number of items in a category to less than 5%. In the matrix level one could prefer to fill it up in a certain way, for example through pursuing a strategy where *bottleneck* and *non-critical* should be as empty as possible.

One of the study cases has even brought the sophistication to a new level, by assessing their end markets in terms of the matrix. This shows the level of customization that can be done towards individual companies.
The authors has tried to find similarities and structure in strategic views across the cases and found some guidelines that will be commented in the following text.

Moving in the matrix

The moving within the matrix is a result of company's pursue of strategies. Figure 6.2-3 gives an overview of the strategies found through the case studies.

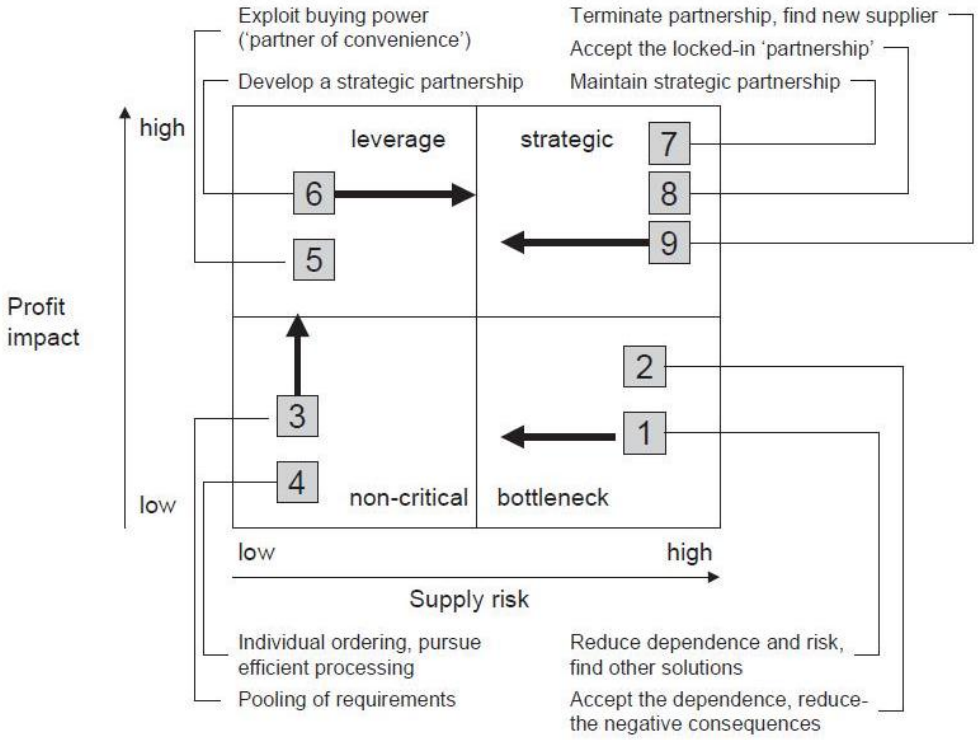


Figure 6.2-3: Overview of the strategic directions for all categories, Source: Gelderman and Van Weele 2003

The case study has given the authors a general view of how the matrix is used further in terms of strategic path. Companies either choose to accept and hold the current position, or they wish to pursue other positions. The reason for holding the position can either be because they believe this is the best position for the item, or that changing the position is believed not possible. The dichotomy between holding the position and moving will be further commented of each category from figure 4.6-5.

- Bottleneck items:

1. Moving position: Standardize and lower product risk meaning that new suppliers are preferable.
2. Withholding position: If no other solution is possible, improve long-term relationship with supplier to ensure supply and quality.

- Non-critical items:
  3. Moving position: Increase quantity which gives higher negotiation strength. Lower direct and indirect cost.
  4. Withholding position: Individual ordering and strengthen effective administration (indirect cost).
- Leverage items:
  5. Withholding position: Maintain partnership and use of exploit buying strength
  6. Moving position: Develop more strategic partnerships. A move from leverage to strategic category should be view as an exception to the rule
- Strategic Items:
  7. Withholding position: Pursue or maintain a long-term relationship with the key suppliers, these are considered very valuable for company.
  8. Withholding position: This position can be a locked position with suppliers having patents, monopoly or high asset specificity.
  9. Moving position: Terminate partnership and find a new due too unacceptable behaviour or similar. Reduce dependence.

This should be considered as an overview of the case studies and what type of movements which can be performed. This positioning is as mentioned only the beginning of the total analysis. The importance of reasoning and discussion over the results is a very important step, which will increase depth of understanding of the complex picture of the purchases in the company.

7 Analysis

This chapter has the intention of highlighting and analysing the model that has been established, and the analysis of the selected purchases in the Eldfisk 2/7S EPC-project. The first section of the chapter emphasizes on the selected model and its customization to fit a project based and global organisation such as Aker Solutions. Further the focus will be concentrated on testing and applying the model to the case-study, i.e. the Eldfisk-project.

7.1 Choice of Model

The background for selecting analysing tool and model was a short presentation of the models and their properties with the Supervisor in Aker Solutions. The questions regarding what Aker Solution would benefit the most from, and what type of model it would be the most interesting to establish for the Company, where discussed. This resulted in a method with company adjusted variables, which determines the matrix positioning of equipment in EPC-projects such as the Eldfisk-project.

The selection of analysing tool is done in the context of the company specific items that are purchased; therefore the model needs to both be structural suited for the business, and have recognisability towards the industry complexity of the purchased items. A purchase of an simple and low cost item like a bolt or a nut, differ from a high cost and project critical gas compressor in terms of influencing risks. Since Aker Solutions operates with purchases in multimillion classes, one-of equipment purchases and detailed engineering on each item, the need of a complex purchasing model is required. The company's terms of an uncomplicated equipment, is to other businesses in general viewed as a highly complicated item, and this needs to be emphasized. Another aspect of selecting model is the need of a model for further use, a model with a qualitative understanding basis would generate specific and accurate knowledge, however the re-use of the model would require a new time consuming analysis. A model based on quantitative measures would be useful without allocating noticeable resources. This was also the background for the customized and re-usable excel spreadsheet which is constructed, and submitted together with the study. The file is programmed and made with the intention of reuse

by company if necessary, or for continue with expanding the study to include more project. Doing this enables the company to use quantitative measures and allocation analysis of packages procured in EPC-projects if favoured.

Aker Solutions has through AE & T's EPC-contracting a project based business model. Theory in this portfolio purchase models assumes in most case-studies continued purchase, and does not emphasize on project industries such as Aker Solutions. The company is forced to meet client's requirements, also in terms of procurement which means that the purchase strategy is to some extent already determined upon contract award. Therefore the model needs to be adjusted to project business, on an overall strategy approach; one of the methods mentioned underneath enables this.

Based on the earlier mentioned models and the case-study by Van Weele and Gelderman (2003) there is three possibilities in creating a company specific model, consensus, weighted factor and one-to-one method. The methods are built up with regards to use and measurement issues (see page 64, table 4.6-6). Following characteristics of the models is recognized (Van Weele and Gelderman, 2003:211).

- Consensus Method
    - Frequency: Irregularly, in respond to changes
    - Main purpose: To identify and develop synergy and leverage across business units
    - Matrix dimensions: Strategic importance and supply risk
    - Determination of factors: During the analysis, basically unlimited
- One-to-one method
    - Frequency: Regularly, fully integrated with daily practice
    - Main purpose: To detect and to cope with supplier dependencies
    - Matrix dimensions: Value of purchases and number of suppliers
    - Determination of factors: In advance, factors are the dimensions
- Weighted Factor Score Method
    - Frequency: Incidentally, on major customer level
    - Main purpose: To assess risk and to identify possibilities
    - Matrix dimensions: Profit impact and supply risk
    - Determination of factors: In advance, limited number

From evaluation and discussion of the methods, the Weighted Factor Score Method is selected as appropriate to establish and apply Aker Solutions and the Eldfisk-project case. This method is overall the most relevant method for applying Aker Solutions, AE & T and the Eldfisk-project, in terms of the criteria's needed for the analysis. The assignment will therefore use the factors in the matrix derived by Kraljic (1983) and Olsen and Ellram (1997) as a study base. The factors will be modified to fit company measurement possibilities, and new factors will be established based on qualitative interview sessions with key-personnel in the company.

7.2 Dimensions

The dimensions which are applied in the model are *profit impact* and *supply risk*. These two separate dimensions will capture differences both internally and externally respectively, based on the factors established. The profit impact has the intention of identify the grade of internal effects on the purchase made, and will represent the affecting factors' corresponding with the risk dimension axis. The supply risk dimension has the intention of identifying and grading the external risks connected with the purchase.

The theory gives different names on the internal and external dimensions. However above mentioned dimensions will be referred to further in the chapter as the *purchase' importance for A E & T* and *supply risk*.

7.3 Dimensional Factors

The method used for determining the dimensional factors of the matrix is based on qualitative interview and background theory. This theory includes Olsen and Ellram (1997) list of criterion's which in this case is used as a model base, while the interviews have been a tool to customize and supplement the theory. According to theory by Olsen and Ellram (1997) the model needs to be modified and supplemented to fit the utilizing company.

The factors for each dimension are split into categories according to the theory, which later will be weighted. The *supply risk* is divided into risks concerning Product, Supply Market and Environmental characteristics, while the *purchase' importance* is divided into Competence, Economic and Image characteristics. These will also be the base for weighting method, which is performed later in the chapter.

The interview sessions for establishing the model were done in two sessions; the first had the intention of increasing the awareness of the risk related to the company, and reveal what factors that was critical and related to overall purchase and the Eldfisk-project. The second session was based on first sessions results and where done to range the importance of the factors, as well as discussing weighting matter.
Following table shows the results of the first interview session and the theoretical factors in each dimension. The factors are as mentioned categorized within each dimension, and are the basis for further factor establishment. In these results the measurability of the factors is not evaluated.

Table 7.3-1: Results from first interview session, Source: Author

Purchase' importance for AE & T	**Supply risk**
Competence factors - The extent to which the purchase is a part of the core competencies - Purchase improves knowledge of buying organisation - Purchase improved technological strength of buying organization - to what extent is the product quality important for the end-product *Economic factors* - Value of purchase - The extent to which the purchase is a part of a final product with a great value added - The extent to which the purchase is a part of a final product with a good profitability - Criticality of the purchase to get leverage with the supplier for other buys - Transaction cost of item cost - Criticality to overall delivery schedule - Production stop - High or low number of variation orders on product *Image factors* - Supplier critical image/brand name. - To what extent the product is affecting HSE	*Product characteristics* - Novelty - Patented technology - Lead time - Production complexity - Product complexity - Engineering complexity - Document complexity - Standardization level - Incomplete inquiry specifications - Proven technology - NORSOK familiarity - Connection to high critical items - Multidiscipline coverage - FEED-design accuracy - Client change possibility - Spare part availability - Criticality priority - Suppliers documentation capabilities *Supply Market characteristics* - Suppliers' power - Suppliers' technical and commercial competence - Number of suppliers - Number of sub-suppliers - Commodity prices

	- Suppliers quality system - Supplier contractual awareness - Possibility to change vendor after PO is placed - Supplier capacity - Delivery time emphasis *Environmental characteristics* - Geographic culture and distance - Market Uncertainty - Risk for opportunistic behaviour

The theoretical base and the first interview, i.e. results, is presented in table 7.3-1 and has emphasized a half-structured interview guide when finding factors for the two dimensions, and narrowing this down to important and measurable issues in an EPC-project. The same measures can be used in EPCI-project, however an EP-project the factors would not be as accurate, and because the actual project does not need to emphasize on further project risks in the same extent.

The factors in the above model comprise both the theoretical factors and factors established through the interviews. It is important to highlight the type of risk which is covered in the factors, since the factors tend to include several risks aspect. An example of this is the complexity risk which can be defined as both purchase risk and operational risk. The operational risk in this case is not of any interests to the model, since the purchase risk is the investigation issue. This issued is noticeable in numerous of the factors, and has been commented in the first interview to ensure correct understanding, and approach in the factor design.

The second interview session was slightly more structured than the first, however still within the half-structured interview type. Here the goal was to establish a weighting base and a ranging list of the two matrix dimensions. Table 7.3-1 was used as a discussion base, wherever meaning of factors seemed unclear for the respondent, this was explained to generate a mutual understanding. The factors were categorized and discussed within the terms of *Great Importance*, *Importance* and *Less Importance*. The respondents was also showed a list of equipment packages from the Eldfisk 2/7S-project, and asked to point out one package which prom their point of view could represent a typical package in the *strategic*, *leverage*, *non-critical* and *leverage* quadrants. This was done to ensure the validity and is used for model testing which will be discussed in end of this chapter.

The second interview led to the final criteria list in table 7.3-2, which includes a presentation of factors that the majority of respondents seemed convinced and certain of, which will affect the EPC purchasing risk. The table also shows the factors which were in general categorized as less important. These factors are recognized as factors which were important for the purchasing, but which for example were an internal organizational issue and therefore not can be seen from this perspective, and therefore seem non-applicable for the model.

Table 7.3-2: Results from second interview session, Source: Author

Purchase' importance for AE & T	**Supply risk**
Competence factors *Great Importance* - to what extent is the product quality important for the end-product Importance - The extent to which the purchase is a part of the core competencies - Purchase improved technological strength of buying organization *Less Importance* - Purchase improves knowledge of buying organisation	*Product characteristics* *Great Importance* - Production complexity - Product complexity - Engineering complexity - Document complexity - Criticality priority - Suppliers documentation capabilities - Multidiscipline coverage - Lead time Importance - Novelty - Standardization level - Proven technology - NORSOK familiarity - FEED-design accuracy - Incomplete inquiry specifications *Less Importance* - Spare part availability - Client change possibility - Connection to high critical items - Patented technology
Economic factors *Great Importance* - Production stop - The extent to which the purchase is a part of a final product with a great value added - The extent to which the purchase is a part of a final product with a good profitability Importance - Value of purchase - Transaction cost of item cost - Criticality to overall delivery schedule - High or low number of variation orders on product *Less Importance* - Criticality of the purchase to get leverage with the supplier for other buys	*Supply Market characteristics* *Great Importance* - Suppliers' technical and commercial competence - Number of suppliers - Number of sub-suppliers - Supplier capacity Importance - Suppliers' power - Suppliers quality system - Delivery time emphasis *Less Importance* - Possibility to change vendor after PO is placed - Supplier contractual awareness - Commodity prices
Image factors *Great Importance* - To what extent the product is affecting HSE *Less Importance* - Supplier critical image/brand name.	*Environmental characteristics* *Great Importance*

	- Geographic culture and distance Importance - Market Uncertainty *Less Importance* - Risk for opportunistic behaviour

After structuring the above list, the factors sourced as great importance has been further evaluated and analysed. Some of the supply risk factors more or less cover the same thing, such as the complexity related ones, which can be summarized in one factor covering all complexity issues. The same matter applies for the supplier and sub-supplier, which also measures the same ting, i.e. increased risk potential with coordinating many companies.

The analysis of the great importance factors shows what the respondents emphasize on when they evaluate risk, based on their competency within supply chain. However it is important to create measurable and distinctive factors, which not covers the same issue. Therefore the analysis of the factors has been made, with regards to the respondent's competence, and with focus on following issues when selecting the final measure factors within both dimensions.

- To which extent the factor are measurable
- To which extent the factor are quantifiable
- Respondents evaluated Importance

Exceptions from this however have been made since some of the factors have been necessary to apply the model even though they are less quantifiable or measurable, due to their high importance. The value of purchase factor has also been selected and evaluated to increase the overall possibility to quantify the models dimensions.

Based on the above mentioned evaluation elements, following criteria's are selected to apply the final model.

Purchase' Importance for AE & T

- To what extent is the product quality important for the end-product

- Production stop
- The extent to which the purchase is a part of a final product with a great value added
- The extent to which the purchase is a part of a final product with a good profitability
- Value of total purchase
- To what extent the product is affecting HSE

Supply risk

- Product complexity
- Criticality Priority
- Multidiscipline coverage
- Number of sub-suppliers
- Number of suppliers
- Geographic culture and distance

The model is as the factors imply consisting of six measurement factors for each dimension. These will measure different parts of the internal and external parts of the purchase. The final criterions are therefore based on both industry knowledge fronted by the respondents and the theory within purchase portfolio models. The factors stated above are in following table described explicitly in terms of their reason for being in the final model within the purchase' importance of AE & T.

Table 7.3-3: Criteria characteristics, measurability and reason for inclusion in model, Source: Author

The extent to which the purchase is a part of a final product with a great value added	*Criteria characteristics*: This is an economic factor that is intended to supplement the other economic factors and are there to strengthen the importance in case of an relative low cost and profit item which still has an own value which is significant *Measurability*: Non-quantifiable, must be measured by evaluation of assumptions. *Reason for inclusion:* Great importance because of the value added for the client, which should be emphasized in a large extent.
Production stop	*Criteria characteristics*: This is the second economic criteria, and has a major impact if occurs. The factor measures the profit loss potential if supplier does not deliver in time. *Measurability*: Non-quantifiable, must be measured by evaluation of assumptions. *Reason for inclusion: Included in model because this has a very strong influence on profitability if problems occur. Equipment which is not delivered in time can jeopardize day fines, of a extremely high character as many other products also can be affected in the building process.*

The extent to which the purchase is a part of a final product with a good profitability	*Criteria characteristics*: this factor is also a big influence on economic perspective, the factor relates to the direct influence of end value. The bigger the part of final value, the more significant purchase. *Measurability*: Non-quantifiable, must be measured by evaluation of assumptions. *Reason for inclusion: Delivery to the right time, cost and quality is an important factor especially from a project point of view. This is influencing highly on the company's profitability*
Value of total purchase	*Criteria characteristics*: This is the major direct economic influence, which is measuring how much the product potentially impacts on the budget and entire project cost *Measurability*: Good, objective and quantifiable measurement. *Reason for inclusion:* The major and direct influencing factor. The company's purchase value is one of the biggest cost drivers, which sometimes is over 50 per cent of the total contract value.
To what extent is the product quality important for the end-product	*Criteria characteristics*: This criterion is the only criteria representing and measuring the competence influence in our purchase, with regards to profitability. It can be seen as a supplementing to the economic factors. *Measurability*: Non-quantifiable, must be measured by evaluation of assumptions. *Reason for inclusion:* This is important due to our business nature where the purchase has direct influence on the final product the company delivers.
To what extent the product is affecting HSE	*Criteria characteristics*: This is the only image factor in which is included, and is presented to safeguard this characteristic. *Measurability*: Non-quantifiable, must be measured by evaluation of assumptions. *Reason for inclusion: Included in the model as a HSE factor is increasing and seen as an important business mind-set for everybody in the industry.*

The corresponding factor which relates to the other dimension is described in the following table, i.e. the supply risk.

Table 7.3-4: Criteria characteristics, measurability and reason for inclusion in model, Source: Author

Product complexity	*Criteria characteristics*: This is the first and emphasized criteria discussed in detail by all respondents, it is present to distinguish the differences and the complexity of the equipment purchased. Initially the factor consisted by several types of complexity, however it was determined to unify these in one important factor. *Measurability*: Non-quantifiable, must be measured by evaluation of assumptions. *Reason for inclusion:* Because of the high complexity of purchased packages, and the importance this has for the overall supply risk. Complexity is a critical issue for suppliers and sub-suppliers.
Criticality Priority	*Criteria characteristics*: This product factor is direct related to company's own criticality priority in terms of design impact features. The criteria's for each priority level, ranging from 1-4 is described in the PEM. *Measurability*: Good, objective and quantifiable measurement. *Reason for inclusion:* The priority is an effective way of utilizing already implemented company specific measures and individual evaluations, which strengthens the validity of the model.
Multidiscipline coverage	*Criteria characteristics*: The document capabilities have through the interviews been argued as a highly important criterion, and should be viewed as a trouble affected area with risk affected. The multidiscipline factors is in the model to cover the aspect of documentation and how this affects the package, the more disciplines, the more complex for the supplier to handle *Measurability*: Non-quantifiable, must be measured by evaluation of

	assumptions. *Reason for inclusion: The document handling requirements in offshore business is among, if not, the highest in the world. It can have a significant effect on the delivery since all documents must be unconditionally approved when final product is delivered.*
Number of sub-suppliers	*Criteria characteristics*: This criterion is supplementing the documentation and organizing grading, and relates to the same as the above mentioned product characteristics measure. *Measurability*: Good, objective and quantifiable measurement. *Reason for inclusion:* Number of sub-suppliers leads to more organizational difficulties both internally and externally, and therefore increases risk.
Number of suppliers	*Criteria characteristics*: This factor will cover the influence of market characteristics has on the supply risk. Another factor which was evaluated, but not included was the market uncertainty, which was intended to cover the fluctuations in the market, since this has a significant effect; however it is not included due to the wish of creating a market fluctuation neutral model. *Measurability*: Good, objective and quantifiable measurement. *Reason for inclusion:* Included to increase the emphasize on static market characteristics of the equipment and supplier base represent
Geographic culture and distance	*Criteria characteristics*: Factor representing the environmental market characteristics and are intended to capture the risk associated with the cultural aspects, which has been described by the respondents as possible risk issue. *Measurability*: Non-quantifiable, must be measured by evaluation of assumptions. *Reason for inclusion: Contractual terms and negotiations can be unclear due to cultural differences. The distance is not an emphasized issue in this case.*

7.4 Evaluation form and question procedure

The evaluation form and questions have been established with a grading scale to each factor. These will both include based on quantitative definite numbers and non-quantitative measures. The grading scale is discussed in theoretic literature which is presented in the theoretical framework, and Olsen and Ellram (1997) recommend a nine-grade scale for each criterion or factor.

The selected scale of this study on all factors is a range from 1 to 4. The reason for this adjusted grading scale, which is different from the theory, is mainly because of two aspects. First of all one could argue that a grade scale ranging the way Olsen and Ellram (1997) fronts, is rising the demands to the evaluator of the purchased item which is analysed. Giving the evaluator a big scale can result in problems with interpreting the scale. Some would argue that the limits would be indefinable to some extent, and some would maybe choose to not use the outer values (1 and 9). The other aspect relating to the issue is the generalization need. In the authors opinion a relatively high generalization, which only can be represented with a more narrow

scale, is required to ensure a more distinctive spread in the matrix. The values are selected because of its generalization limits and since the questionnaire is to be evaluated by different individuals with little information of the model itself.

The insurances of valid questions is an important factor, and as mentioned above the individual grades would be hard to define if a large range were to be used. To ensure right use of the range in the questionnaire, it is determined to use a supplementing text in the scale for the individual reference. By doing this the problem of unclear meaning of the point is avoided, which is critical when only using six grading factors per axis. It is also important to describe and form the wording of the question in a clear, unbiased and easy way, making it easy for the evaluator to fill out the form.

To safeguard the correct outer limits (1 and 4) were determined before the inner values (2 and 3). This was made on all non-quantifiable measures, while the quantifiable ones were to some extent determined by other factors such as the PEM within the PEM priority factor, and with regards to the procurement total value. The number of sub-suppliers and suppliers, and the multidiscipline factors the grading are based on non-defined outer limits. The terms “more than” and “less than” is utilized, comprising more than needed in the scale. The following table shows the wording used for questions and the text corresponding to each scale number.

Table 7.4-1: Questionnaire basis, Source: Author

Interrogative	Explanatory text	Range scale
-To which extent is the purchase a part of a final product with a great value added?	Low Medium High Critical	1 2 3 4
-In the event of production stop on the equipment package, what effect would this have on the overall construction schedule?	No influence Slightly influenced Influence High influence	1 2 3 4
- To which extent is the purchase a part of a final product with a good profitability?	Low Medium High Critical	1 2 3 4
- In what cost category does the equipment package belong?	Package value less than 15 million Value between 15 and 40 million Value between 40 and 70 million Value above 70 million	1 2 3 4
- To what extent is the product quality important for the end-product?	Low Medium High Critical	1 2 3 4
- To what extent the product is affecting HSE	Low Medium High Critical	1 2 3 4

-Compared to other equipment packages, how complex do you consider the package to be?	Low Slightly Relatively high High technical level	1 2 3 4
-What Criticality Priority has the equipment package been given?	PEM Priority 4 PEM Priority 3 PEM Priority 2 PEM Priority 1	1 2 3 4
-To what extent is this package affecting many disciplines?	Low Medium High Critical	1 2 3 4
-How many sub-suppliers does the package include?	Less than 1 2-3 4-5 More than 5	1 2 3 4
-How many suppliers are capable of delivering this package?	More than 5 4-5 2-3 Just the awarded supplier	1 2 3 4
-To what extent is the geographic culture and distance affecting the professional relationship?	Nothing Low affect Noticeable Strong	1 2 3 4

7.5 Weighting of the factors

The Narsimhan (1983) weighting model is utilized (please see page 58), and is the next step in the establishment of the company specific purchasing portfolio model. The method is emphasizing on weighting factors based on non-overview practice. Instead of having an overall view of each factor and weighing them in comparison to numerous other factors, it uses an approach were only two factors is evaluated at one time, using the formula build up described in the theoretical part. The method is used were three or more weights was needed and is described explicitly in the theoretical chapter referred to above. The weighting with two bottom factors, are established with background in the qualitative interview.

The factor describing Market characteristics are not of this nature, therefore only the interview session backgrounds for the weighting. One could use the full method of Narsimhan in these cases as well; however it does not seem necessary, since the method at that point not have a simplifying option. With the second interview session and theory as a basis, following weighing table was established.

Table 7.5-1: Weighting calculation with Narisimhan method, Source: Author

Purchase impact	Competence factor	Economic factor	Image factor	Geometric mean	Weight
Competence factor	1,00	1,00	2,00	1,26	**34 %**
Economic factor	1,00	1,00	9,00	2,08	**56 %**
Image factor	0,50	0,11	1,00	0,38	**10 %**
Sum				**3,72**	**100 %**

Economic factors	Production stop	Value of total value	Purchase with great value added	Purchase with a good profitability	Geometric mean	Weight
Production stop	1,00	2,00	3,00	4,00	2,21	**45 %**
Value of total value	0,50	1,00	1,00	3,00	1,11	**23 %**
Purchase with great value added	0,33	1,00	1,00	3,00	1,00	**21 %**
Purchase with a good profitability	0,25	0,33	0,33	1,00	0,54	**11 %**
Sum					**4,86**	**100 %**

Supply risk	Product characteristics	Supply Market characteristics	Environmental Characteristics	Geometric mean	Weight
Product characteristics	1,00	4,00	5,00	2,71	**67 %**
Supply Market characteristics	0,25	1,00	4,00	1,00	**24 %**
Environm. Characteristics	0,20	0,25	1,00	0,37	**9 %**
Sum				**4,08**	**100 %**

Product characteristics	PEM criticality priority	Supplier documentation capabilities	Equipment complexity	Geometric mean	Weight
PEM criticality priority	1,00	4,00	2,00	2,00	**58 %**
Supplier documentation capabilities	0,25	1,00	1,00	0,63	**18 %**
Equipment complexity	0,50	1,00	1,00	0,79	**24 %**
Sum				**3,42**	**101 %**

Hierarchic chart were used with Narsimhan method, and shows the categorization of the final model, both within Purchase' importance for AE & T and the Supply risk. The percentages used both indicate the relative value in their category, and the total value in the model. The percentages is applied the constructed and enclosed excel spreadsheet (see included CD).

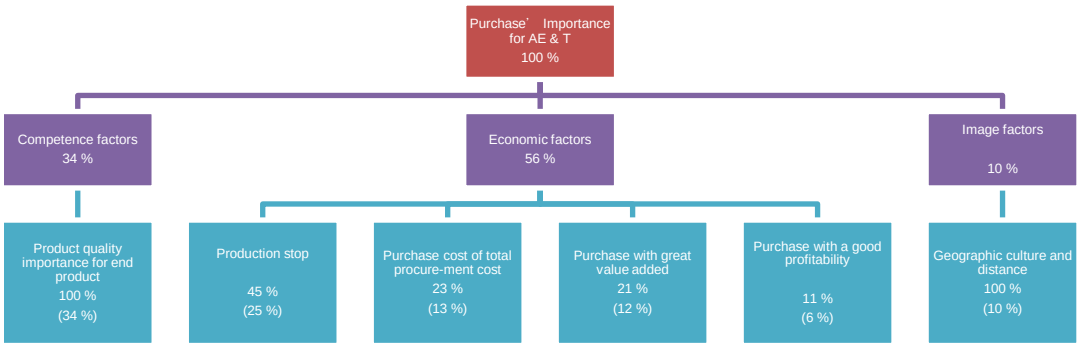


Figure 7.5-1: Purchase' Importance Hierarchy, Source: Author

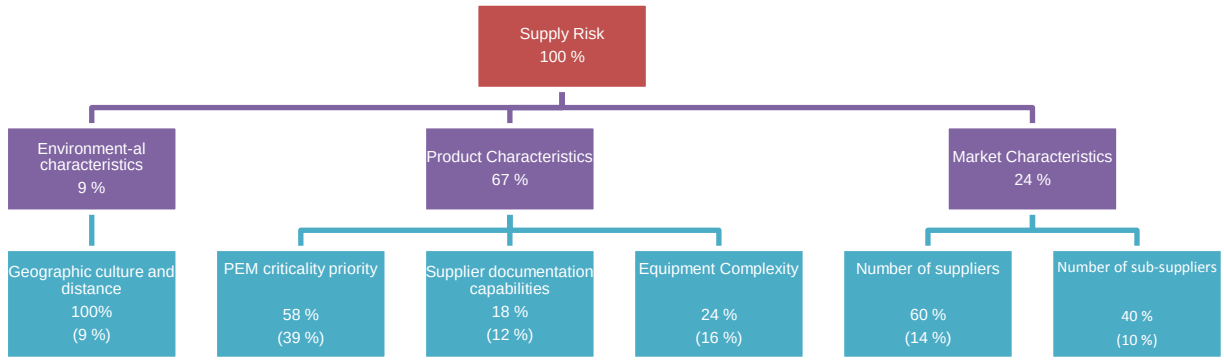


Figure 7.5-2: Supply Risk Hierarchy, Source: Author

7.6 The excel spreadsheet

The study has now established an Aker Solutions customized purchasing portfolio model which can be used for analysing packages in Aker Solutions. The intention of the study is to analyse the equipment packages in the Eldfisk project. However it is important to construct the study so further work may be possible, therefore an excel model is constructed.

The excel model is based on simple programming from Visual Basic implemented to the spreadsheet, connected with two buttons where the first is programmed to apply each evaluated package into the existing matrix, and the other to refresh the

spreadsheet. This simplifies the process of including more packages from other projects if this would be of interests to Aker Solutions.

The spreadsheet contains limitations concerning the number of possible packages, and the maximum viewable are limited by 70 packages at once. Other limitations to this model are the criteria's, which has a maximum of 6x2 possible factors, with 4 different answer alternatives.

The model is partially locked, since the majority of users only need to access the open area, this is market in purple colour. The administrator of the model would need access to the percentage and question area if restructuration and re-weighting the whole model. In table 7.6-1, a simple explanation is enclosed to ensure correct understanding of the model.

Table 7.6-1: Excel Sheet Guidance, Source: Author

Cell reference (cell)	Cell	Description
Profit impact and supply risk	A4/A29	Describes the questions chosen the user.
Alternatives	B4	Wording and description of answer alternatives
Grading range	C4	Value alternative for the user
Actual grade	D4	Open cell row, intended to type in the selected value
Relative weight	E4	The category weight
Total weight	F4	The individual factor weight in the model
Weight grading	G4	The adjusted grading value, after grading is made.
Row I to L	-	The list of packages evaluated

7.7 Model testing and calibration

The first version model is now ready for testing and calibration to achieve a right picture of the purchased equipment items in the Eldfisk-project. This is necessary to ensure that the use of the model is accurate and provides the spread needed for a categorization of purchased items.

To ensure this, the respondents used in the interviews were asked based on their experience to select a package from the project which, and allocate it in the matrix. This resulted in a final list with packages that should have a significant spread in the

matrix. Following packages were selected and allocated in the respective quadrants by the respondents.

Table 7.7-1: Testing and calibration items, Source: Author and Respondents

Leverage • ER245 – Separators, K/O Drum and Scrubber • ER284 – Electrochlorination Package • ER297 – Compact Flotation Unit • ER258 – Flare Gas Recovery/Ejector	Strategic • ER254 – Diesel Generator • ER302 – Firewater/Seawater Pump • EI171 – Safety and Automation System
Non-Critical • ER331 – Forklifts Trucks/Trolleys • ES107 – Misc. Safety Equipment • ER335 – Workshop Equipment	Bottleneck • ET380 – Telecom Equipment and Material • ES101 – Free Fall Lifeboat System • ES103 – Escape Chutes

Another aspect which the testing is designed to focus on is the readability and understanding of the questionnaire. An easy understanding of the form is required for the method and classification of the packages to be believable. This is partially a critical point if strategy is based on the model, which implies that a wrong allocated package will be classed and approached wrong. This can result in a false and wrong strategy for the item.

Therefore, to investigate the spread and general feasibility of the model, the package responsible buyers were asked to answer the questionnaire. The questionnaire was submitted in paper format for each packages and then collected for implementation in the test model.

The matrix in figure 7.7-1 shows the result both after and before adjustments. The adjustments were done after questionnaire results were analysed and described with an additional “A” after package number, indicating the position after adjustments.

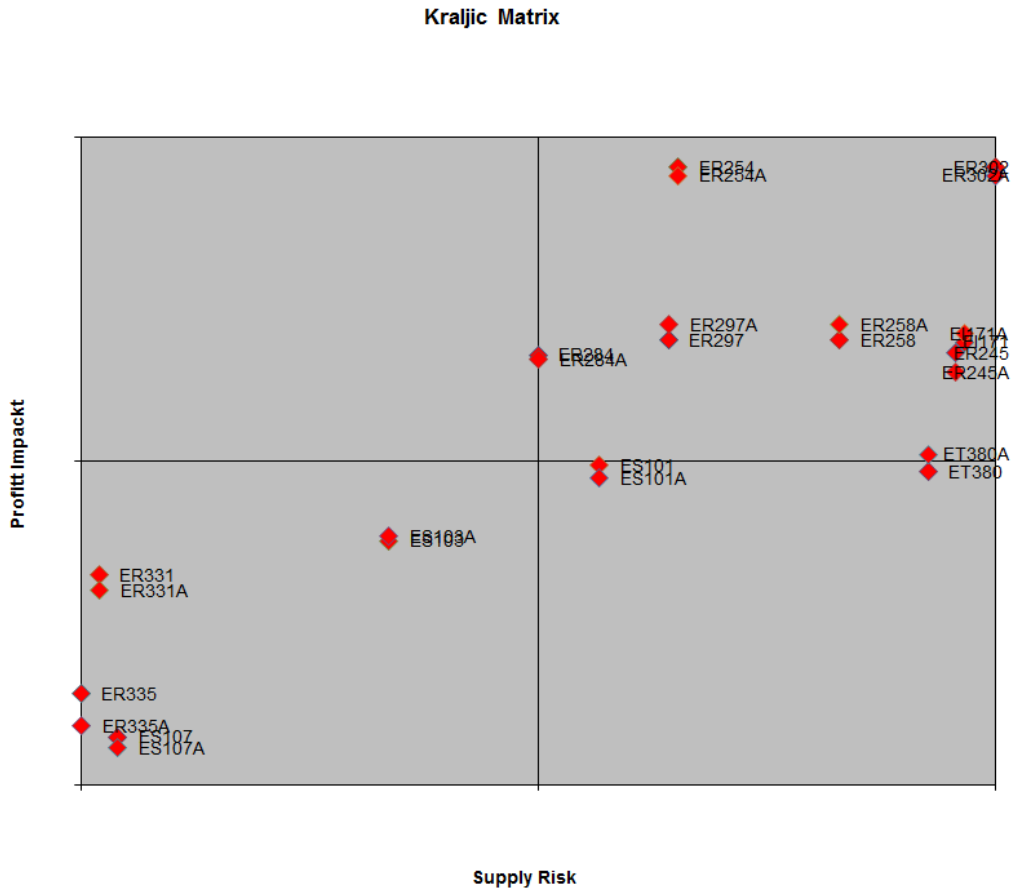


Figure 7.7-1: Results from testing the model, Source: Spreadsheet/Author

The questionnaire results was analysed by screening results and what the PRB had answered for each package. It was also emphasized on the result spread in the different packages. The intention of this was to find questions were there was little or no variation, and re-evaluate the weighting. Question number 12 and 10 in table 7.4-1 (page 79) had unsatisfying spread, and were therefore reweighted from the original model. This led to re-weighting of other questions that were evaluated as more significant. Question 7 and 11 was therefore given more significance than originally.

7.8 Final Model

The model was finalized with the testing adjustments; the result is seen in figure 7.8-1. The model is based on each individual PRB to evaluate their package through the questionnaire. This means that one person's evaluation is allocating individual packages, this means that the actual model is less valid, and should be assured more than this thesis does. One could then ask the question if the result is valid,

which the answer would be that it might not. For the actual result to be more valid there is one general rule through quantitative theory and questionnaire basics which should be present, which is, a representative sample. For further validating the results, one should expand the model to other projects. For example by using several key-persons per package for their evaluation, and generate a mean that would be used for allocating the package. However, since the model itself has been the main purpose of the study, the resources are prioritized on validating the model, and not the result using it. This corresponds with the actual strategy establishment that is derived in the result chapter, which also is emphasized in the study. In other words the importance of creating a good and valid model with strategy directions has been the main goal.

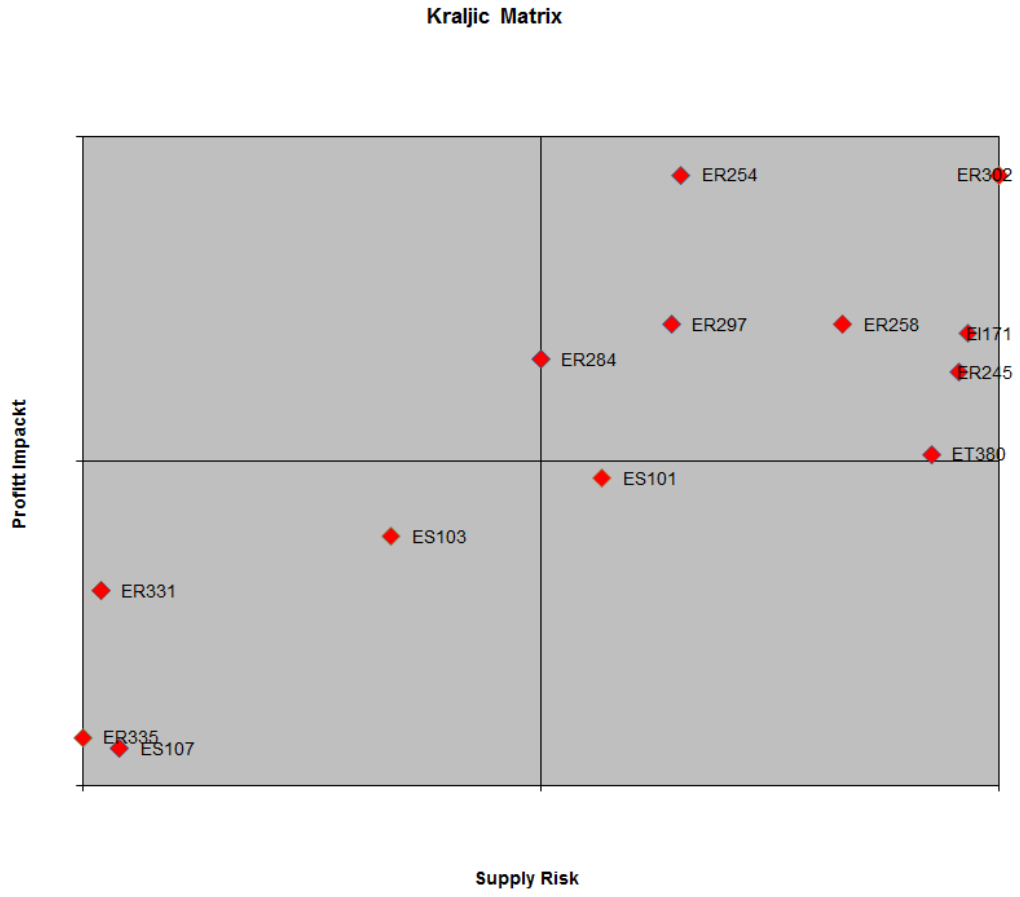


Figure 7.8-1: The final model, Source: Excel spreadsheet/Author

7.9 Transaction cost from Aker Solutions point of view

Transaction cost theory has in previous chapter described several issues regarding decision-making that needs to be emphasized in terms of make-or-buy decisions. This text will view these aspects in the context of Aker Solutions EPC-purchasing supplier relationships, and the link to purchasing portfolio model categorizing. The

text is intended as a comment based on transaction theory, on the overall purchasing picture, and will also be an underlying base in the result chapter.

The theory splits the transaction costs in to behavioural and governmental effect, which in Aker Solutions case represents the type of goods that are purchased and their typicality together with the contractual terms and risk.

7.9.1 Behavioural aspects

The behavioural aspects of the purchasing in Aker Solutions, is in general most connected to the contractual difficulties related to complex equipment packages and patented technology. The opportunism is both related to the transaction specificity (which will be discussed later) and the hold-up problem. According to the study's respondents, some suppliers seem to use their market power be less tractable when they are the only supplier with possibilities to deliver according to requirements. In the purchasing portfolio model we find the packages with most of these problems in the high supply risk quadrants, i.e. the strategic and bottleneck. One could argue for that these packages theoretically should have a high cost related to contractual terms and negotiations. This is because such suppliers also are in most likely a financial good position, operating in industries with high entry barriers. From this point of view the need of moving these strategically to the less supply risk quadrants is high. If this is possible, these items would generate a significant cost reduction since their bargaining power is their major strength. The theory argues for vertical integration when opportunistic behaviour is high, and therefore one could claim that the higher supply risk an item represents, the higher incentive for Aker Solutions to vertical integrate.

7.9.2 Governmental aspects

The governmental aspects of the purchasing done in EPC-projects should be seen on as very relevant and is both an argument for and against vertical integration, and has less relevance towards the model. The theory discusses how asset specificity, environmental uncertainty and frequency should be evaluated in terms of strategy. The asset specificity in Aker Solutions case can be considered high due to the one-of type of good which equipment packages represent. Nearly all items in this category purchased are custom made for the company, which gives the good a less possible value for others. This reduces the incentive to make, and strengthens the argument

of continuing the already established strategy. The other factors mentioned in theory are the purchasing frequency and the environmental uncertainty. The governmental issue of uncertainty which reflects the future unknown factors are neglected in this study, which leaves the frequency issue. This has been through the interviews also been discussed as an important but difficult issue of the project organization. The respondents argued for possibilities to use frequency as a buying advantage by ordering more at once, which would create leverage towards the supplier. However it seems hard to utilize this possibility in practice.

7.10 Applying the model to oil and gas industry procurement

Applying this model to the oil and gas sector is creating an overall issue of how the supply chain and total market specifics relates to each other. The model creates an underlying base which can be seen from the individual company, as this study does, but also from a broader point of view.

The oil and gas business within EPC-projects is worldwide with several competing levels depending on how big and niche the company are located in. The oil companies outsource engineering, procurement, constructing and installation depending on project specifics. The contractor will again outsource what it finds reasonable to other sub-contractors, and so on; this is showed in figure 7.10-1.

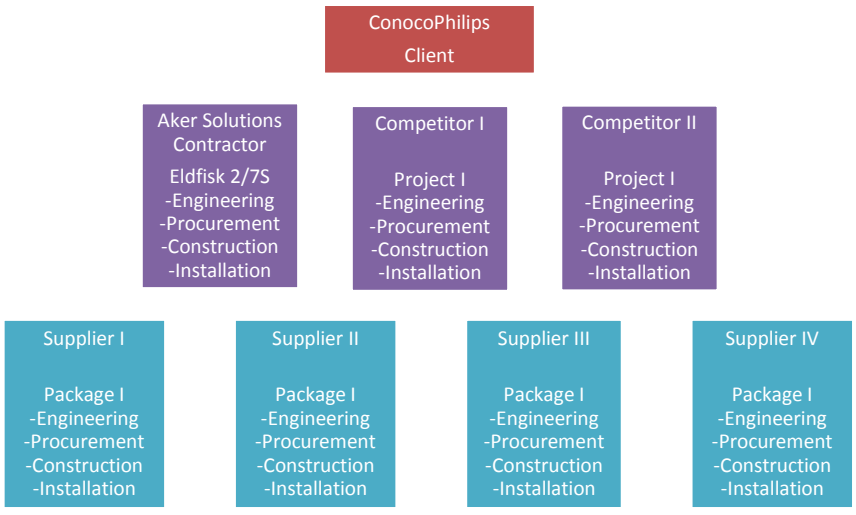


Figure 7.10-1: Market Structure, Source: Author

The figure shows a simplified model over the industry levels build up, competition determine which EPC-contractor and suppliers that gets awarded, similar to the levels under, which not are a part of this model.

This means that Aker Solutions competitors can in many ways benefit from some of the moves which are made by Aker Solutions as an EPC-supplier. Aker Solutions could for example conduct supplier development strategy to achieve higher competition in an equipment specific oligopoly market. Then the competitors will also achieve benefits of delivering projects with lower cost. However one must consider what Aker Solutions are seeking, and how the company wants the clients to appear in the market. A contractor which seems “gold plated” is not necessarily the one oil company would prefer. The company therefore needs to evaluate what type of strategic plan to achieve; either it is being a latecomer, or a first mover. According to the interviews Aker Solutions seeks the first mover strategy.

The strategies presented in the results show a theoretical approach and alternative to which strategy the company can follow.

8 Results

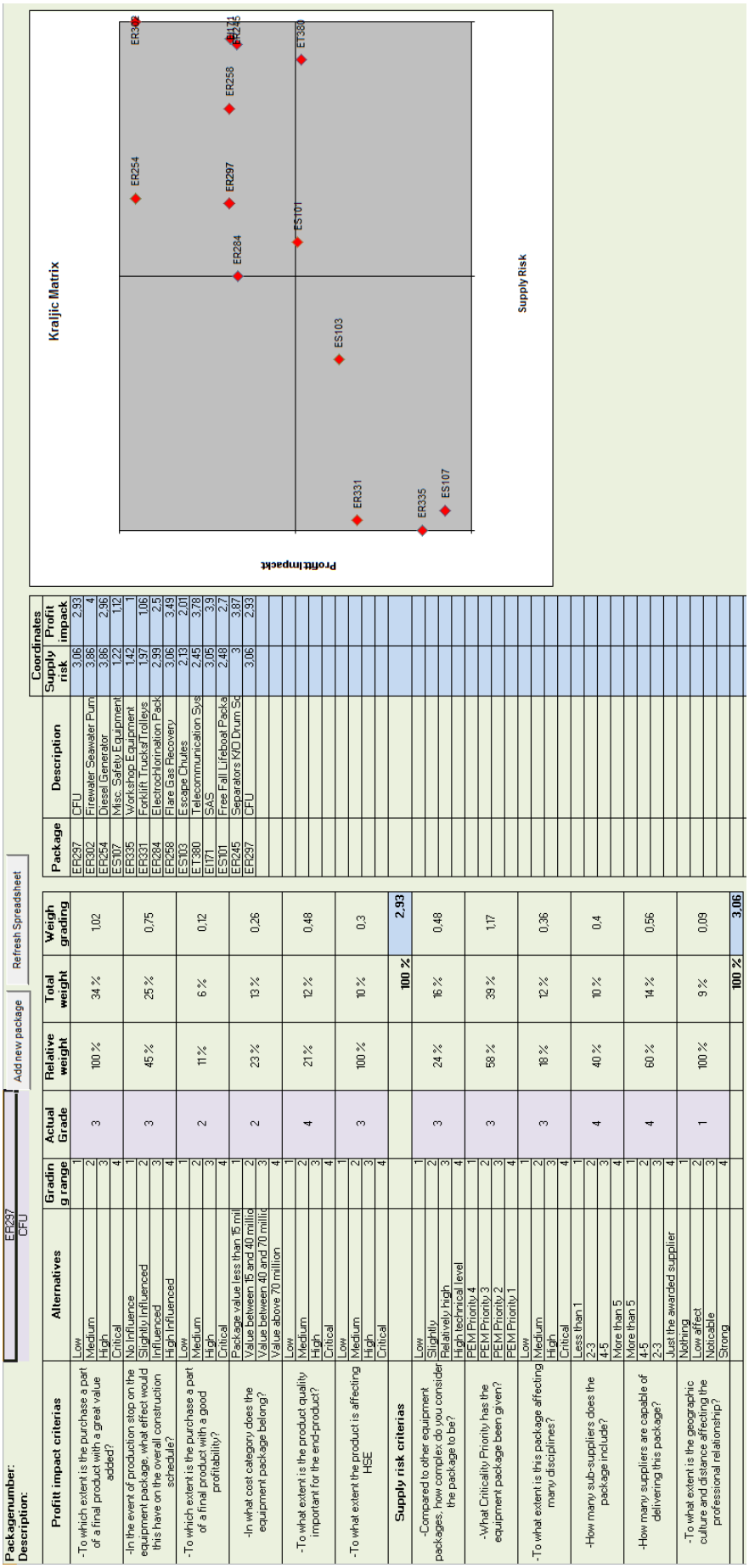
This chapter will present and describe the results found in this study, critical factors of the study and suggestions for future results. The chapter finishes with a conclusion and discussion with respect to the thesis statement in the introduction chapter.
The final model from previous chapter, combined with the knowledge form various theorists, creates a basis for establishing possible strategy directions regarding purchase and supply chain management within Aker Solutions, AE & T and the EPC-project business area.

8.1 Re-using the constructed model

The model created in this study generates a tool for Aker Solutions to classify the way equipment items are being purchased in Aker Solutions current EPC-business. It generates a set of strategic possibilities based on the allocated position.
The model is constructed in such a way that it is possible to apply other projects and thereby generate quantitative measures for how items are being purchased in general. The customization of the model is based on Eldfisk 2/7S, however as this has many similarities with other projects, the model is transferable. The excel spreadsheet is easy in use for others than the author, with typical generalized factors. The results presented later in this chapter can also easily be applied to another EPC-project than the Eldfisk 2/7S.

The generality of the model should be taken into consideration when using the model and the positioning of items is the first step in discussing purchases. This means that the model should not be considered as the final result regarding each product, but more like a guide to the position of the item since the model has a limited number of measurements. This is especially important where the positions in nearby the limits of the other quadrants, where one factor can be the determinant of the position.

The purchasers that assisted in testing the model where informed to use other purchases in the company as background base for evaluation questions based on non-quantitative measures. This also needs to be emphasized in further use of the company modified model.



Profit impact criterias	Alternatives	Gradin g range	Actual Grade	Relative weight	Total weight	Weigh grading
- To which extent is the purchase a part of a final product with a great value added?	Low	1				
	Medium	2	3	100 %	34 %	1,02
	High	3				
	Critical	4				
-In the event of production stop on the equipment package, what effect would this have on the overall construction schedule?	No influence	1				
	Slightly influenced	2	3	45 %	25 %	0,75
	Influenced	3				
	High Influenced	4				
- To which extent is the purchase a part of a final product with a good profitability?	Low	1				
	Medium	2	2	11 %	6 %	0,12
	High	3				
	Critical	4				
-In what cost category does the equipment package belong?	Package value less than 15 mill	1				
	Value between 15 and 40 millio	2	2	23 %	13 %	0,26
	Value between 40 and 70 millio	3				
	Value above 70 million	4				
-To what extent is the product quality important for the end-product?	Low	1				
	Medium	2	4	21 %	12 %	0,48
	High	3				
	Critical	4				
- To what extent the product is affecting HSE	Low	1				
	Medium	2	3	100 %	10 %	0,3
	High	3				
	Critical	4				
Supply risk criterias					**100 %**	**2,93**
-Compared to other equipment packages, how complex do you consider the package to be?	Low	1				
	Slightly	2	3	24 %	16 %	0,48
	Relatively high	3				
	High technical level	4				
-What Criticality-Priority has the equipment package been given?	PEM Priority 4	1				
	PEM Priority 3	2	3	58 %	39 %	1,17
	PEM Priority 2	3				
	PEM Priority 1	4				
-To what extent is this package affecting many disciplines?	Low	1				
	Medium	2	3	18 %	12 %	0,36
	High	3				
	Critical	4				
-How many sub-suppliers does the package include?	Less than 1	1				
	2-3	2	4	40 %	10 %	0,4
	4-5	3				
	More than 5	4				
-How many suppliers are capable of delivering this package?	4-5	2				
	2-3	3	4	60 %	14 %	0,56
	Just the awarded supplier	4				
- To what extent is the geographic culture and distance affecting the professional relationship?	Nothing	1				
	Low affect	2	1	100 %	9 %	0,09
	Noticable	3				
	Strong	4				
					100 %	**3,06**

Package	Description	Coordinates Supply risk	Coordinates Profit impact
EP297	CPU	3,06	2,93
ER302	Firewater Seawater Pum	3,86	4
ER254	Diesel Generator	3,86	2,96
ES107	Misc. Safety Equipment	3,22	1,12
ER335	Workshop Equipment	1,42	1
ER331	Forklift Trucks/Trolleys	1,97	1,06
ER284	Electrochlorination Pack	2,99	2,5
ER258	Flare Gas Recovery	3,06	3,49
ES103	Escape Chutes	2,13	2,01
ET380	Telecommunication Sys	2,45	3,78
EI171	SAS	3,05	3,9
ES101	Free Fall Lifeboat Packa	2,48	2,7
ER245	Separators KO Drum Sc	3	3,87
EP297	CPU	3,06	2,93

Figure 8.1-1: The final Excel Spreadsheet. Source: Author

8.2 Purchasing resources

The resources allocated for purchase in Aker Solutions are significant, and in many ways the oil company's determine a great set of boundaries for the company. This needs to be evaluated when selecting strategies, and implemented in the strategy thinking. Even though the resources in many ways are bounded by the client, there are possible ways to generate a better resource allocation.
Aker Solutions has over the recent years established several hubs of engineering facilities in low cost countries. By consideration this in terms of the model, possibilities for effective purchasing within some items seems possible. The matrix non-critical items are such a possibility, and should be recognized.

8.3 Strategic possibilities within the matrix

The moving in the matrix can be approached from several different views. The already established and determined strategy can be supplemented using the model. Another option is to use the model without firm established boundaries and create totally new approaches. The strategy plans needs to be emphasized and evaluated, when company creates overall strategy for the company. Following section will present an options and contributions to the established strategy plans in Aker Solutions and AE & T, within EPC-contracting business, from a purchasing portfolio point of view.

The strategy options is based on the Gelderman and Van Weele (2003), supplemented with the industry and company knowledge in terms of the thesis statements. Each quadrant will be strategically derived in two directions, either withholding the position or moving the position within the matrix.

8.3.1 Bottleneck

Bottleneck position is generally viewed as an unwanted position to possess for an item because of the high supply risk. The firm is risk averse and would if possible therefore want move towards the less risk quadrant which is represented in the non-critical quadrant. This also applies for Aker Solutions and the cluster of the packages located in this quadrant. The items in this position can also be object for an even greater risk than shown in the quadrant because of the supplier specifics. A supplier that for example is operating in several other businesses will be affected by other

risks, which to some extent also will apply for the companies clients. This type of risks is important to recognize and are one of the reasons Aker Solutions should avoid bottleneck items if possible. However there are often situations where the company is forced to utilize a product with these distinctive characteristics. Since these situations are not preferred, a main goal should be to avoid such positions through long term strategy, and have an option for the short term strategy. This can be done through both vertical integration and supplier development in a long term perspective; however the short perspective is far more complex and has fewer alternatives. The two way option of moving the item in the quadrant or to withhold the position is under described in the two following sections.

- Relocating is the main goal of this quadrant which is done by reducing risk and supplier dependence. The theoretic strategy suggests introducing new suppliers. This strategy will in Aker Solutions case reflect a long term development of suppliers to increase the competition in the niche markets. There should be investigated other supply solutions for the good, which means that possibilities to search in other markets can be profitable. However it will raise the question of; who should take the cost if supplier development and vertical integration is the selected strategy. This question can be raised because the supplier development will benefit both the oil companies, and Aker Solutions competitors.

- The other option of withholding the position, the company implicit accepts the conditions of bottleneck items. In this case the focus should be to reduce the negative consequences of the position. The strategy approach for this is complex, and to some extent it would be beneficial to simplify and make the procurement practice more effective. However this will probably not generate a significant cost reduction. This type of reduction is also mentioned in section 3.3, and is argued as a less optimizing strategy when it comes to supply chain cost reduction. One option for doing this more effective is establishment of frame agreements by the company on the most usual equipment packages. Frame agreements are in the Eldfisk-project established by the Oil Company and not Aker Solutions.

8.3.2 Strategic

The strategic items are to some extent the same nature as the bottleneck in terms of the wanted risk reduction. However the items in this quadrant are as the name point out, fairy more strategically important for the company, and the cost of the items are also fare more significant. The items symbolize the core of the delivery, and are very sensitive for the company. Items at this position are not only exposed for the technical risks emphasized in the model, but also to the general market and environmental uncertainty. The typical item in this position in a single/sole source and operates in markets with high entry barriers, where long term approaches towards other marked actors is necessary. Other items which we find located in this position are the patented goods, these are of course impossible to include in any other strategy than withholding and accept the position. The strategy directions of this quadrant are divided into three, which is described under.

- This position also has a moving potential similar to the bottleneck. Most of suppliers of this position are supplying high technical and advanced systems which create a dependence relationship. According to Gelderman and Van Weele (2003) the option of moving towards the leverage quadrant is the most typical strategy. This would reduce the supply risk and benefits the company supply conditions. To enable this, the same strategy as mentioned in the bottleneck quadrant applies, and can be done by expanding the market. Implicit this means introducing new suppliers, or helping new suppliers to enter the market. Theory suggests that the reason for moving can be related to conflicts in the supplier-buyer relationship. For Aker Solutions however this is not the case because of the project organization nature with time limited purchases. However the theoretical aspect of developing and building long term relationship with suppliers is reasonable and required.

- The withholding position strategy in the strategic category is divided in two different approaches, where one is to accept a locked in relationship and the other is to maintain the relationship. Transferring this to the company's point of view it seems like the company is forced into both of these issues. As an oil company selects more or less the procurement strategy for the company, it is therefore forced to select certain supplier's through the procurement process,

which they need to deal with within the timeframe of the purchase order. This often creates the hold-up problem referred to in the vertical integration framework, section 1.1.7. In general term this leads to the conclusion that the company can end up in this position whenever a purchase order is placed and the supplier has either a patented technologic advantage, or the market situation has oligopoly recognition factors. The company has little influence to avoid this; however the strategy solutions for such problems can be to use contractual means. In order to mitigate this Aker Solutions can establish supplier databases which keeps record of earlier supplier relationships.

8.3.3 Non-critical

The non-critical items are generally defined as routine items, where the strategy should be based on efficiency. The typical recognition factors of this quadrant are low value items with numerous supplier availability and short lead times. Since these items have fewer problems connected to them within supply chain, there is still possible to develop strategy in several directions for the packages that are positioned here. The theory suggests the two regular ways of approaching, i.e. withholding position or move to another quadrant. The most likely quadrant to reposition in will obviously be the leverage quadrant, due to the fact that the company is risk averse. In Aker Solutions the products of this quadrant are relatively complex, however compared to other company equipment relatively low. The overall company strategy for items positioned in this category should be as theory describes to ensure effective handling and thereby cost reduction.

- The strategy for moving item position in this case are in theory recommended through increasing the quantity, which gives higher negotiation power, to reduce indirect and direct cost. This possibility is also present in Aker Solutions, however it would in this business case be significantly more difficult due to the project organization specifics where all supplier are selected and awarded once per project. This move has maybe a better survival rate in other business cases where continued production is the business nature, and the supplier relationships are longer and more stable. Because of this the move to another quadrant seems less reasonable than the other cases, however it

does not mean it cannot be done. If this approach were to be initiated the organizational difficulties would concern the implications of procuring items for projects which has different delivery schedules.

- The withholding position strategy for the items positioned in this quadrant is as described above, the most likely scenario considered the implications that could arise. The theoretic approach for withholding position is described by Gelderman and Van Weele (2003), they recommend individual ordering and strengthening effective administration. Aker Solutions must in this case find a way to mitigate this approach by deriving the organizational structure related to these purchases. One way of pursuing such case could be to evaluate the documentation required for purchasing this type of items. The procedure in Aker Solutions today is use of the same documentation base on all equipment purchases, independent of which purchase is made, i.e. both strategic items and non-critical items. Considering the nature of the purchasing this seems unnecessary since the products has major differences in contractual needs.

8.3.4 Leverage items

The leverage position is in many ways similar to the non-critical due to the same supply risk level; however they have differences in their significance for the actual delivered product, or in Aker Solutions case, the project. This quadrant is in the most wanted position of the four quadrants for any equipment, and a typical destination position for the move strategies described in above sections. The theoretic view of items positioned here are despite this split in the two directions of withholding or moving, naturally the withholding strategy is more likely to be used than the other. This would also most likely be the case in Aker Solutions business case, since the company is forced to mitigate the oil company's desire of competitive bidding on most equipment packages.

- The moving position possibility in this case is viewed as the less likely for the company to approach. However it may be an attractive approach in special cases, such cases will not be discussed in this study. The theoretic recommendation is to reposition through development of more strategic partnerships. This would then move the item from the leverage to the strategic

position; however this would increase the supply risk and dependency of the suppliers and therefore should be viewed as an exception from the rule.

- The withholding position strategy is as mentioned the most likely option to utilize for Aker Solutions. This is theoretically done by maintain partnerships and use of exploit buying position. In the company case the exploit of buying position is utilized as a default strategy through the competitive bidding, and it seems like the items positioned here are the in fact the ones that the overall strategy probably has the most effect, since the products of this nature has significant amount of possible suppliers.

9 Discussion

This chapter will shortly discuss the methods being used for this study, the background for selecting them, and what possibilities that could have been selected instead.

9.1 Discussion

The choice of using a purchasing portfolio model to categorize the purchases of Eldfisk 2/7S-project was decided after evaluating other methods to approach the thesis statement. For answering the thesis statement the need of a categorising method for packages was required, because of the large differences in the purchases. Another option of solving this could have been to use quantitative surveys to determine differences, however this would lead to one-time knowledge in this exact project and was considered less beneficial for the company than a model which is possible to reuse in other projects.

The method of using qualitative interviews for determining the model factors was evaluated as predetermined due to the information type. Only experienced and interdisciplinary key-personnel with significant company overview knowledge have the possibility to recognize a wide range of risk factors, which was needed to establish the model. The ranking of the factors could have been solved through quantitative method, by survey. This would possibly have resulted in quite similar results, but it would open the risk of more misunderstanding in what types of risks which was discussed and so on. A second qualitative interview session was instead determined, with use of the already enlightened respondents. The second session was therefore used to supplement the outstanding and unclear factors from the first session and for doing the ranking process. This sorted out some misunderstandings, and in the authors opinion resulted in a valid and reliable result.

The quantitative data collection method was used as a basis for approaching the study for due to the academic background of the author. The use of numbers and mathematical approaches are in the authors' nature as a mechanical engineer student. Throughout the study the need of a quantitative research method evolved as the best solution for creating the model. The method was therefore carefully studied

and initiated; the literature for acquiring the knowledge was primarily through Robert K. Yin which is considered a pioneer in case study approaches.

The practical reality in Aker Solutions purchasing business is quite different than the theoretical approach allows. This reality might uncover certain facts and issues that are not considered in the study, either because it is not revealed through the study or because it would lead to further questioning which would require a new study. However it is still considered appropriate and beneficial to create the model for internal use and as one of many information sources when evaluating purchases. In a theoretical view such as this study, the excluding of issues and boundaries are necessary to uncover and find results.

10 Conclusion

This chapter are summarizing and concluding the Master study performed for Aker Solutions and AE & T. The intention of the chapter is to answer the thesis statements in terms of the final report. The chapter finishes of with suggestions for future research, based on findings and thoughts throughout the study period.

10.1 Action plans

Based on the strategic possibilities described in the result chapter, there are some strategies that are more likely to generate success and possibly lead to a sustained competitive advantage for Aker Solutions and AE & T in the EPC-industry.

With use of the final customized purchasing portfolio model in practice, the packages are allocated within the matrix' quadrants, and thereby is characterized by its location. The final strategy of the packages is therefor based on where the packages are placed through the established questionnaire. This implies that a package location after the distinguishing procedure, determines the recommended strategy.

The recommendations made are leading to the final questions of what the company should do to meet the higher competition in the EPC market. The theory describes the different aspects of possible solutions and strategies for the company to approach.

The strategies which are described on the next page have generally two focus areas, i.e. reducing risk and reorganizing. Reducing risk is described in positions of strategic and bottleneck, where both are has quite similar strategy. The non-critical is the only one where restructuring and changing of procedure is recommended. However this is one solution of categorizing the suppliers, and there is other similar methods that can be used. Following strategies are recommended for Aker Solutions to utilize depending on where the equipment items are positioned.

Table 10.1-1: Final Conclusive Strategy, Source: Author

Bottleneck	Moving strategy through supplier development and vertical integration. Intention of this is to establish more approved suppliers in the niche markets of the different packages.
Strategic	Moving strategy through supplier development and vertical integration to generate more new approved suppliers where entry barriers and complexity allows this. Withhold position and build relationships in cases where the other solution is impossible or the item is patented.
Non-critical	Withholding position through competitive bidding. Reduce documentations requirements where this is possible, to increase competition in the markets. The procurement process can be performed in Aker Solutions hubs in low cost countries enabling use of alternative local markets.
Leverage	Withholding position by strengthening and streamlining the procurement process.

The strategies described above answers the thesis statement of the thesis indirectly; however it can be clarified with a more direct point of view. The strategies imply that active supplier development and possibly vertical integration can be a benefitting strategy; however it is determined by the supply risk and the importance of the selected package.

It is more likely to benefit from these strategies if they are to be conducted in low cost countries, since the overall cost level is less than in the European market. Although this is theoretically a benefitting solution, it is several aspects of the strategy that gets problematized if the company where to putting it out in practise. One of the major problems connected to low cost countries are the HSE mind-set, which are not present in many of the low cost countries. The oil and gas industry, promoted by the oil companies, has a great concern for this factor when utilizing suppliers.

Another aspect of evaluation is the follow up possibility of the company, if the recommended strategy was to be adopted. To what extent the company allocates resources to meet this issue will determine how successful the strategy is. The company has as mentioned in the introduction a set of offices in low cost countries,

which could be used for implementing the strategy. However it is important to select locations with precautions and find suppliers with best possible potential, and ensure that local externalities are in line to meet the demands of the oil and gas supplier industry.

The selection of these strategies can be valuable for the company. To gain an advantage and bring the strategies out in practice it is several actions and activities that need to be investigated. Primarily AE & T need to investigate the background and goal of their current superior supplier strategy and evaluate these. Uncovering this strategy will give an answer of which direction that are possible to pursue, either it is a first mover which has been claimed in interview sessions, or a latecomer.

When developing strategies that are to be implemented in companies, the importance of correct observations to base strategies on is a critical and crucial factor. Therefor my recommendations need to be safeguarded through further study activities, to determine an absolute decision base. This applies on the package allocation uncertainty. Single persons has been used to allocate packages, this needs to be made more quantitative valid, by applying the model to additional EPC projects. This is possible as the packages are numbered equally in similar on-going projects. By doing this the packages position in the matrix will be based on several project and strengthen the validity of the item positions. The two main focus areas of reorganising and reducing risk is linked to new actions which is needed to proceed the realization of conclusive strategy in the thesis.

When refereeing to reducing risk, it is recommended that AE & T establishes a task force that investigates and locates suppliers in low cost countries. These should have a future potential of delivering niche products that are determined the most critical in terms of supply risk in the matrix. The suppliers should have the potential to become a AE & T equipment supplier through either supplier development or vertical integration. The importance while doing this supplier analysis are location and their development potential.

The reorganizing focus area is recommended to be met with new analysis of which packages in the non-critical quadrant that has the greatest potential of cost reduction.

The thesis suggests that these packages are mainly categorized by high welding and assembly work. The thesis also recommend a task force for developing a less complicated set of standard documentation that are to be used for less complicated packages that the non-critical quadrant represent.

Further deriving in terms of strategy should not be done without significantly more information basis, and extends beyond the limitations of this Master Thesis. The following text will therefor suggest future research which can be based on and relate to subjects of this thesis.

10.2 Suggestions for future research

The work of creating a company specific purchasing portfolio model has resulted in a significant knowledge and information exchange between the author and company personnel. Several issues has been brought up in the qualitative interview session with the skilled respondents and with the supervisor at the company which is a key person with great experience and knowledge within Aker Solutions supply chain strategy development. Significant amount of data has been evaluated use in the study, and various topics and interesting views has discussed, and due to the study limitations has been excluded.

One of the interesting issues uncovered through the study is the relationships between single suppliers and the company. The possibility of creating a matrix described in chapter 6, with axis dimensions of supplier and company strength could generate more in-depth strategies for the individual packages. Another direction which could also have been interesting is to expand the original model to a three dimensional model, where last axis would cover the performance of the selected supplier in the project.

The author and supervisor discussions has also approached the subject of using the international hubs of low cost countries for procuring construction intensive packages that are less complex. This thought was initiated by the supervisor with background in other studies which showed that packages with high amount of welding and construction has a high cost reduction potential if performed in typical low cost

countries. A model with dimensions of construction intensity and supply risk could recognize the packages suited for outsourcing.

11 References

Following references is used throughout the study.

11.1 Respondents

Andersson, Erik
Senior Buyer, Aker Engineering & Technology

Erik has work experience from major technical and strategic purchases in the company and has also participated as a buyer or senior buyer in over 10 projects. Erik started working in the company in 1986.

Bakker, Anders
Mechanical Department Manager, Aker Engineering & Technology

Experience within mechanical equipment and material, has worked over 14 years in Aker Solutions with technical supply chain activities.

Holten, Jorolv
QS Manager, Kvaerner Stord

Specialised in quality surveillance and has worked in the company for many years.

Lileng, Carsten
Vice President, Aker Engineering & Technology

Worked more than 30 year with procurement and risk evaluation and participated in 17 projects connected to the company. Primary work consists of determining structure of how project packages are put together.

Stiansen, Valborg Mogen
Procurement Manager, Aker Engineering & Technology

Valborg has worked more than 15 years within supply chain in Aker Solutions, and has participated in the procurement management group in a period of 2 years. She has possessed several leading positions in the company's supply chain management.

11.2 Supplementing personnel

Aas, Charlotte – Senior Buyer, Aker Engineering & Technology

Andersson, Erik - Senior Buyer, Aker Engineering & Technology

Hagevik, Preben – Senior Buyer, Kvaerner Stord

Jensen, Jan Børge – Senior Buyer, Kvaerner Stord

Madrid, Lena – Senior Buyer, Aker Engineering & Technology

Mørk, Edward – Procurement Manager Eldfisk 2/7S Project, Kvaerner Stord

Shehatta, Elisabeth Skjefstad – External Consultant

Thorvaldsen, Elin – Equipment Supervisor, Aker Engineering & Technology

Velichco, Liudmila – Advisor, Aker Engineering & Technology

11.3 Litterature

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12 Attachments

12.1 Attachment 1: Qualitative Interview Guide

Interview Guide – Qualitative interview

Main target:
Identifying factors of *supply risk* and purchases *impact on business*.

Agenda:
1st Session, 17-20 min

- Introduction of the model – 3 min
- Identify supply risk factors – 7 min
- Identify impact on business factors – 7 min

2nd Session, 20 min

- Range supply risk factors – 5 min
- Range impact on business factors – 5 min
- Discuss the weighting of ranged factors – 3 min
- Suggest one package for each quadrant in the model – 2min

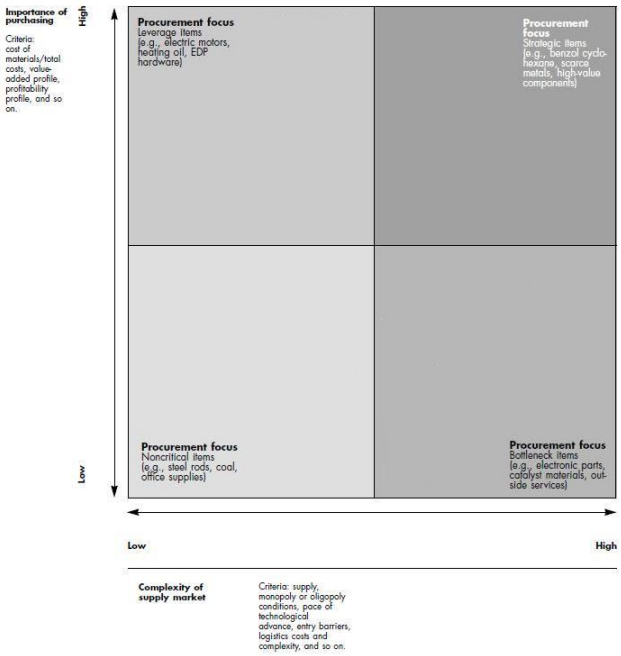
Table 1st Session: Factors

Impact on Business	Supply Risk

Table 2nd Session: Range of factors

Impact on Business	Weighting Suggestion	Supply Risk	Weighting Suggestion
Competence factors		*Product characteristics*	
Economic factors			
		Supply Market characteristics	
Image factors			
Health Safety and Environment (HSE)		*Environmental characteristics*	

Package suggestion:



12.2 Attachment 2: Questionnaire

Questionnaire for Equipment Packages in Eldfisk 2/7S-project

This questionnaire is a part of Carl Petter Larsson's Masters Study, where a purchasing portfolio model is established. The model has the intention to categorize equipment packages in the Eldfisk-project, based on this questionnaire. The results of this survey will be applied the final model, which will be a basic for establishing possible supply chain strategies.

Package Number:……

Package Description:……..
Please highlight your choice of scaling.

Interrogative	Explanatory text	Range scale
-To which extent is the purchase a part of a final product with a great value added?	Low Medium High Critical	1 2 3 4
-In the event of production stop on the equipment package, what effect would this have on the overall construction schedule?	No influence Slightly influenced Influence High influence	1 2 3 4
- To which extent is the purchase a part of the final delivery with a good profitability?	Low Medium High Critical	1 2 3 4
- In what cost category in NOK does the equipment package belong?	Package value less than 15 million Value between 15 and 40 million Value between 40 and 70 million Value above 70 million	1 2 3 4
- To what extent is the product quality important for the end-product?	Low Medium High Critical	1 2 3 4
- To what extent the product is affecting HSE	Low Medium High Critical	1 2 3 4
-Compared to other equipment packages, how complex do you consider the package to be?	Low Slightly Relatively high High technical level	1 2 3 4
-What Criticality Priority has the equipment package been given?	PEM Priority 4 PEM Priority 3 PEM Priority 2 PEM Priority 1	1 2 3 4
-To what extent is this package affecting many disciplines?	Low Medium High Critical	1 2 3 4
-How many sub-suppliers does the package include?	Less than 1 2-3 4-5 More than 5	1 2 3 4
-How many approved suppliers are capable of delivering this package?	More than 5 4-5 2-3 Just the awarded supplier	1 2 3 4
-To what extent is the geographic culture and distance affecting the professional relationship?	Nothing Low affect Noticeable Strong	1 2 3 4

Thank you for participating with your knowledge!

12.3 Attachment 3: Excel Coding for Spreadsheet

```
Private Sub Worksheet_SelectionChange(ByVal Target As Range)

    'remCor
    'makeCor

    If Target.Address = "$D$54" Then
        Range("D5").Select
    End If

    If ActiveCell.Column > 8 And ActiveCell.Column < 13 Then
        Dim t As Integer
        For t = 5 To 75
            If ActiveCell.Row = t Then
                If Selection.Columns.Count = 4 Then
                    setValues (Range("I" & t, "L" & t))
                Else
                    Range("I" & t, "L" & t).Select
                End If
                GoTo slutt
            End If
        Next t
    End If
slutt:

    'unlockMe
End Sub

Function setValues(tmp)

    ThisWorkbook.ActiveSheet.Unprotect
    Dim atmp(0 To 3) As String
    Dim stmp As String, ptmp As String
    Dim i As Integer, tmpCell As Integer
    tmpCell = 5
    i = 0

    ' Henter verdiene
    For Each c In tmp
        If i <> 2 Or i <> 3 Then
            atmp(i) = c
        End If

        If i = 3 Then
            atmp(i) = CStr(ActiveCell.Offset(0, 2).Formula)
        End If

        If i = 2 Then
            atmp(i) = CStr(ActiveCell.Offset(0, 3).Formula)
        End If
```

```
      i = i + 1
   Next

   If atmp(0) = "" Then
      Range("D5", "D25").Value = 0
      Range("D30", "D50").Value = 0
      GoTo fail
   End If

   stmp = atmp(3)
   ptmp = atmp(2)

   Dim teller As Integer, tmpTeller As Integer, tmp1 As Integer
   teller = 1
   tmp1 = 0

   Dim formTmps(0 To 5) As String
   For o = LBound(formTmps) To UBound(formTmps)
      tmpTeller = InStr(teller, stmp, "+")
      tmpTeller = tmpTeller - tmp1

      If o = 0 Then
         formTmps(o) = Right(stmp, Len(stmp) - teller)
         formTmps(o) = Left(formTmps(o), tmpTeller - 2)
         GoTo skip1
      End If

      If o <> 5 Then
         formTmps(o) = Right(stmp, Len(stmp) - teller + 1)
         formTmps(o) = Left(formTmps(o), tmpTeller - 1)
      Else
         formTmps(o) = Right(stmp, Len(stmp) - tmp1)
      End If
skip1:
      teller = teller + tmpTeller
      tmp1 = tmp1 + tmpTeller
   Next

   teller = 1
   tmp1 = 0
   Dim formTmpp(0 To 5) As String
   For s = LBound(formTmpp) To UBound(formTmpp)
      tmpTeller = InStr(teller, ptmp, "+")
      tmpTeller = tmpTeller - tmp1

      If s = 0 Then
         formTmpp(s) = Right(ptmp, Len(ptmp) - teller)
         formTmpp(s) = Left(formTmpp(s), tmpTeller - 2)
         GoTo skip2
```

```
        End If

        If s <> 5 Then
            formTmpp(s) = Right(ptmp, Len(ptmp) - teller + 1)
            formTmpp(s) = Left(formTmpp(s), tmpTeller - 1)
        Else
            formTmpp(s) = Right(ptmp, Len(ptmp) - tmp1)
        End If
skip2:
        teller = teller + tmpTeller
        tmp1 = tmp1 + tmpTeller
    Next
    ' Slutt på henting av verdiene

    ' Setter verdiene i feltene
    Dim init As Integer, tmpPro As String, tmpRes As String
    For i = LBound(formTmpp) To UBound(formTmpp)
        init = (4 * (i + 1)) + 1
        tmpPro = Range("F" & init).Value
        tmpRes = "=" & formTmpp(i) & "/" & tmpPro

        On Error Resume Next
        Range("D" & init).Formula = tmpRes
        If Err <> 0 Then
            tmpRes = Replace(tmpRes, ",", ".")
            Range("D" & init).Formula = tmpRes
        End If
    Next

    For i = LBound(formTmps) To UBound(formTmps)
        init = (4 * (i + 1)) + 26
        tmpPro = Range("F" & init).Value
        tmpRes = "=" & formTmps(i) & "/" & tmpPro

        On Error Resume Next
        Range("D" & init).Formula = tmpRes
        If Err <> 0 Then
            tmpRes = Replace(tmpRes, ",", ".")
            Range("D" & init).Formula = tmpRes
        End If
    Next

    Range("B1").Value = atmp(0)
    Range("B2").Value = atmp(1)
    ' Slutt på verdiene i feltene
fail:
    ThisWorkbook.ActiveSheet.Protect

End Function
```

```
Function makeCor()
   ActiveSheet.ChartObjects("Chart 1").Activate
   Dim i As Integer
   Dim o As Integer
   o = 1
   For i = 5 To 75
      ActiveChart.SeriesCollection.NewSeries
      ActiveChart.SeriesCollection(o).Name = "=ActiveSheet!$I$" & i
      ActiveChart.SeriesCollection(o).XValues = "=ActiveSheet!$L$" & i
      ActiveChart.SeriesCollection(o).Values = "=ActiveSheet!$K$" & i
      ActiveChart.SeriesCollection(o).MarkerBackgroundColor = RGB(255, 0, 0)
      ActiveChart.SeriesCollection(o).MarkerStyle = 2
      ActiveChart.SeriesCollection(o).MarkerSize = 10
      ActiveChart.SeriesCollection(o).ApplyDataLabels
      ActiveChart.SeriesCollection(o).DataLabels.ShowSeriesName = True
      ActiveChart.SeriesCollection(o).DataLabels.ShowValue = False
      o = o + 1
   Next i
End Function

Function remCor()
   ActiveSheet.ChartObjects("Chart 1").Activate
   For Each r In ActiveChart.SeriesCollection
      r.Delete
   Next

End Function

Function unlockMe()
   ThisWorkbook.ActiveSheet.Unprotect
End Function
```