

A sourcing evaluation model for transportation and installation services of wind turbines

- The case of E.ON Vind Sverige AB

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Abstract

Title: A sourcing evaluation model for transportation and installation services of wind turbines
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Issue of study: Today's global competition forces manufacturing companies to re-evaluate their existing processes, technologies, manufactured parts and services in order to focus on strategic activities. The question whether to make or to buy goods or services represents a problem faced by many companies when deciding between keeping technologies/processes in-house or purchasing them from an outside supplier. In today's society, an increasing number of business functions are being outsourced. Therefore, choosing sources of supply is one of the most critical decisions a purchaser makes when it comes to the sourcing activity.

The renewable energy projects worldwide have seen growth both in number of projects and potential investment value in 2010. Today there are many renewable alternatives, where wind power is one on the rise. The Swedish government decided in 2009 about a national plan for wind power, which equals a total production of 30 TWh (where 10 TWh is ocean based) in 2020. A big challenge facing the wind power industry is the logistics of transporting oversized parts over extremely long distances.

Due to the strongly increasing demand of wind power, the question regarding the most appropriate sourcing alternative for

transportation and installation services arises. This is an unexplored area in the present situation.

Purpose: The purpose of this study is to contribute to a deeper knowledge about the process of selecting sources of supply for transportation and installation services for wind turbine generators (WTGs).

Objectives: The objectives of this thesis are;

- To identify and describe the necessary activities for and the challenges associated with transportation and installation services of WTGs.
- To develop a general evaluation model for the sourcing alternatives for transportation and installation services of WTGs.
- To adapt the general evaluation model to E.ON Vind, and apply it to the Knäred project.

Methodology: This is a qualitative study with a systems approach, which can be illustrated by a funnel divided into three steps before the conclusions and final remarks are presented. The first step includes the necessary activities for and the challenges associated with transportation and installation services of wind turbines, the possible supplier combinations and the key factors recognized. A general sourcing evaluation model is created and adjusted before the final version is presented. Lastly, the evaluation model is adapted and applied to E.ON Vind Sverige AB. Both primary and secondary data is used in this thesis.

Conclusions: The necessary activities identified from manufactured to commissioned WTG are transportation, lift, installation and coordination. The challenges associated with these activities are taken into consideration when the key factors for choosing the appropriate supplier and sourcing alternative are identified. These factors are divided between supplier and project specific criteria and used as evaluation criteria in the developed SAWPS-model (Sourcing Alternatives for Wind Power Services). The outcome of the model is the most feasible solution regarding selection of supplier and sourcing category for a specific project. When applying the evaluation model to the Knäred project, a full turnkey solution was found to be the most suitable solution based on the given information and E.ON Vind's current situation.

Key words: Sourcing, evaluation model, transportation and installation services, wind power, wind turbine generators (WTGs), key factors.

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1. Introduction

This chapter aims to give the reader an introduction to the project. The background and issue of study is presented, which leads to the purpose of this study and the objectives that are to be fulfilled. Moreover, the delimitations, the target group and the outline of the report are established.

1.1 Background

Increasing importance of service sourcing

Today's global competition forces manufacturing companies to re-evaluate their existing processes, technologies, manufactured parts and services in order to focus on strategic activities. The question whether to make or to buy goods or services represents a problem faced by many companies when deciding between keeping technologies/processes in-house or purchasing them from an outside supplier. The ability to make such decisions in a structured and rational way is likely to improve a company's overall performance.¹ This type of decision making is preferably done by basing the organization's development on processes and a process-oriented approach, which will help to gain a comprehensive view over the company. In turn, by gaining this comprehensive view, this will facilitate the identification of focus areas within the company. It will also strengthen the employees' ability to work towards a common goal.² A focus on processes and a process-oriented approach is also considered as being the determinate of successful projects³.

Relating to the question whether to make or buy goods or services, it is agreed upon that a company's core competence never should be outsourced. According to Quinn & Hilmer (1994)⁴, core competences are skills or knowledge sets, not products or functions. They are flexible, long-term platforms that are capable of adaption or evolution and are limited in number: generally two to three. A company's core competences are a unique source of leverage in the value chain, and areas where the company can dominate/perform activities important to the customers better than others. They are also elements that are important to customers in the long run and embedded in the organization's systems. These are all activities that provide long-term competitive advantage and should be closely protected. Other activities are objects for outsourcing.⁵

¹ University of Cambridge (www)

² Ljungberg & Larsson (2001)

³ Cooke-Davies (2002)

⁴ Quinn & Hilmer (1994)

⁵ Ellram & Billington (2000)

In today's society, an increasing number of business functions are being outsourced, hence being bought from a supplier rather than being made in-house⁶. Therefore, procurement, which is defined as the acquisition of goods or services⁷, becomes more important. Before selecting the procurement strategy for a certain project, whether it is on a strategic or detailed level, it is necessary to first identify the factors which will determine the most suitable procurement strategy for the project. These factors are; the key objectives and constraints of the project; the risks that may arise during the delivery of the project and how those risks might best be dealt with, and; the level of complexity of the project. The procurement strategy best suited to the project will be the one that best aligns with the key objectives and constraints of the project. It is also the one that deals most appropriately with the identified risks, and that suits the level of complexity of the project.⁸

A term that has become increasingly popular within purchasing is sourcing. Whilst procurement includes all activities required in order to get the product from the supplier to its final destination, sourcing focuses on the tactical purchasing. This activity relates to developing the most appropriate supplier strategy for a certain commodity or service. A sourcing strategy describes what type of relationships to pursue and how many suppliers the company favors for that commodity or service.⁹ Choosing sources of supply is one of the most critical decisions a purchaser makes when it comes to the sourcing activity¹⁰.

In earlier studies, price and delivery were the single most important criteria in organizational buying decisions. Today, there are multiple evaluation criteria that need to be taken into consideration when choosing a supplier¹¹, which calls for complex procurement situations.

1.2 Issue of study

Increasing demand for renewable energy

World energy-related carbon dioxide emissions are expected to increase by 43 percent between 2007 and 2035¹². However, greater energy efficiency and new technology hold promise for reducing greenhouse gases and solving this global challenge¹³. The renewable energy projects worldwide have seen growth both in

⁶ van Weele (2005)

⁷ Kerzner (2001)

⁸ Department of Public Works (2008)

⁹ van Weele (2005)

¹⁰ Quayle (1998a)

¹¹ Bharadwaj (2004)

¹² U.S. Energy Information Administration (www)

¹³ U.S. Environmental Protection Agency (www)

number of projects and potential investment value in 2010¹⁴. Today there are many renewable alternatives, where wind power is one on the rise¹⁵.

The expansion of wind power

Despite the global economic crisis, new wind power capacity installations in 2009 reached a record high of 38 GW. Over the five-year period end-2004 to 2009, annual growth rates for cumulative wind power capacity averaged 27 percent. The total world capacity in 2009 was 160 GW, which is a substantial increase from 1996, when the wind power capacity was around 10 GW as shown in Figure 1 to the right.¹⁶

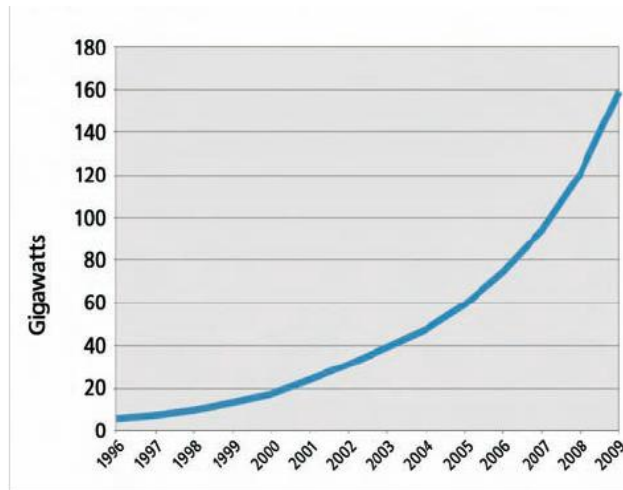


Figure 1. Wind power, existing world capacity, 1996-2009¹⁷

In Sweden, the amount of renewable energy in 2009 was about 42 percent (calculated as the ratio between renewable energy and final usage)¹⁸. According to a prognosis in the government's action plan for renewable energy, Sweden's renewable share of energy usage will constitute 62,9 percent in 2020¹⁹. As a step in this direction, the Swedish government decided in 2009 about a national plan for wind power, which equals a total production of 30 TWh (where 10 TWh is ocean based) in 2020²⁰. In 2010, wind power produced about 3,5 TWh²¹.

When constructing a wind power project, many internal as well as external actors are involved²². With a goal to almost ten double the capacity of wind power within the next ten years, both the occupation and the competition in the business will increase drastically.

¹⁴ Renewable Energy Focus (www)

¹⁵ REN21 (2010a)

¹⁶ Ibid.

¹⁷ REN21 (2010b)

¹⁸ Energimyndigheten (www)

¹⁹ Svensk Energi (www)

²⁰ Energimyndigheten (2010)

²¹ Regeringskansliet (www)

²² The European Wind Energy Association (2009)

Sourcing in the wind power industry

A big challenge facing the wind power industry is the logistics of transporting oversized parts over extremely long distances. Because of the unusual length, shape and weight of wind energy components, logistics such as transportation, lift and installation are complex and exceptionally expensive. Among the issues are the traffic backups, road damage, size of project site, coordination and cost.²³ One of the companies facing this type of challenge is E.ON Vind Sverige AB (as from now called E.ON Vind), which is a part of E.ON Climate and Renewables. E.ON Vind is currently seeking for alternatives regarding the sourcing of transportation and installation services of wind turbine generators (also called WTGs or wind turbines).²⁴ An evaluation of sourcing alternatives within the wind power industry is an unexplored area in the present situation.

1.3 Purpose

The purpose of this study is to contribute to a deeper knowledge about the process of selecting sources of supply for transportation and installation services for wind turbine generators (WTGs).

1.4 Objectives

By achieving the objectives presented below, the purpose will be accomplished.

The objectives of this thesis are;

- To identify and describe the necessary activities for and the challenges associated with transportation and installation services of WTGs.
- To develop a general evaluation model for the sourcing alternatives for transportation and installation services of WTGs.
- To adapt the general evaluation model to E.ON Vind, and apply it to the Knäred project.

1.5 Delimitations

Due to a limited timeframe delimitations are set, in order to improve accuracy, precision and reliability. The evaluation model will only address the sourcing alternatives for transportation and installation services within the wind power industry. Furthermore, it will only take onshore wind power projects into consideration. The thesis will focus on the development of an evaluation model for sourcing alternatives of WTG transportation and installation services and not the execution of it. Opportunities and risks associated with this type of services will be highlighted.

²³ CN North America's Railroad (2009)

²⁴ Axelsson, conversation (2010)

1.6 Target group

The target group for this thesis is the academic world, as well as companies active within the construction of WTGs. Such stakeholders are wind power/energy companies, manufacturing companies, firms providing transportation and/or installation services and the case company E.ON Vind. Apart from the wind power business, companies within other businesses involving complex transportation and installation services will also assimilate some information from this thesis.

1.7 Outline of the report

Chapter 1: Introduction – *This chapter aims to give the reader an introduction to the project. The background and issue of study is presented, which leads to the purpose of this study and the objectives that are to be fulfilled. Moreover, the delimitations, the target group and the outline of the report are established.*

Chapter 2: Methodology – *This chapter aims to present the work process and the different methodological choices that have been made. Several methodological approaches, research strategies, data collection methods, research methods and scientific reasoning are reviewed in order to find the most suitable ones. Moreover, credibility and criticism of the sources are discussed.*

Chapter 3: Theoretical framework – *The third chapter presents the theoretical framework used in this thesis. Initially, the specifics of logistics services are presented. An introduction to different sourcing alternatives, sourcing options and supplier combinations is given. Thereafter, Multiple Criteria Decision Analysis, the multiple criteria problem, the construction of a qualitative value scale and supplier selection criteria are reviewed. Lastly, collaborative transportation management and cost-benefit analysis are presented.*

Chapter 4: WTG transportation and installation services – facts and key factors – *In this chapter, the collected information constituting a part of the foundation of the evaluation model is presented. Firstly, the makeup of a wind turbine is described and the necessary activities within a wind power project is recognized and reviewed. Possible turnkey solutions within the wind power industry are identified and key factors concerning transportation and installation services, derived from interviews and existing evaluation models, are recognized.*

Chapter 5: Creating an evaluation model – *In this chapter, the initial model for evaluating sourcing alternatives of wind turbine generator transportation and installation services is created. Firstly, a matrix illustrating the potential sourcing combinations within the wind power industry is presented. Then the key factors recognized in the previous chapter are divided between supplier and project*

specific criteria. Thereafter, the two steps in the evaluation model, Sourcing alternatives of wind power services (SAWPS), are described and exemplified.

Chapter 6: Adjusting the model and presenting the final version – *In this chapter, the SAWPS-model created in the preceding chapter is adjusted through interviews. After adapting the model to the interviewees' feedback, the final version of the SAWPS-model is presented.*

Chapter 7: Applying the SAWPS-model to E.ON Vind – *This chapter focuses entirely on E.ON Vind and the Knäred project. Firstly, a brief introduction to E.ON Vind and more detailed description of Construction is given. Thereafter, some background information about the Knäred project is presented before adapting the SAWPS-model to E.ON Vind and applying it to Knäred. Conclusions regarding risks and possibilities are then compiled before reviewing possible implications on Construction's process map.*

Chapter 8: Conclusions and final remarks – *In this final chapter, the conclusions and contributions with regards to the purpose and objectives of this thesis are presented. Thereafter, the general applicability of the results is discussed. Lastly, final remarks concerning potential improvements and areas for further research are given.*

The references used in this thesis are compiled in Chapter 9. In the Appendix, the following information is presented;

- Appendix 1. The foundation of the adjustments conducted to the SAWPS-model
- Appendix 2. Process map Construction
- Appendix 3. Identified suppliers
- Appendix 4. Responses and rating Step 1
- Appendix 5. Responses and rating Step 2

2. Methodology

This chapter aims to present the work process and the different methodological choices that have been made. Several methodological approaches, research strategies, data collection methods, research methods and scientific reasoning are reviewed in order to find the most suitable ones. Moreover, credibility and criticism of the sources are discussed.

2.1 Work process

The work process of this thesis, illustrated in Figure 2 below, is formulated with regards to the objectives established in 1.4 Objectives. Step 0 indicates a pre-study where the aim is to gain a general understanding of the wind power industry. The result of this step will not be presented in the thesis, but will rather work as a comprehension foundation for the authors.

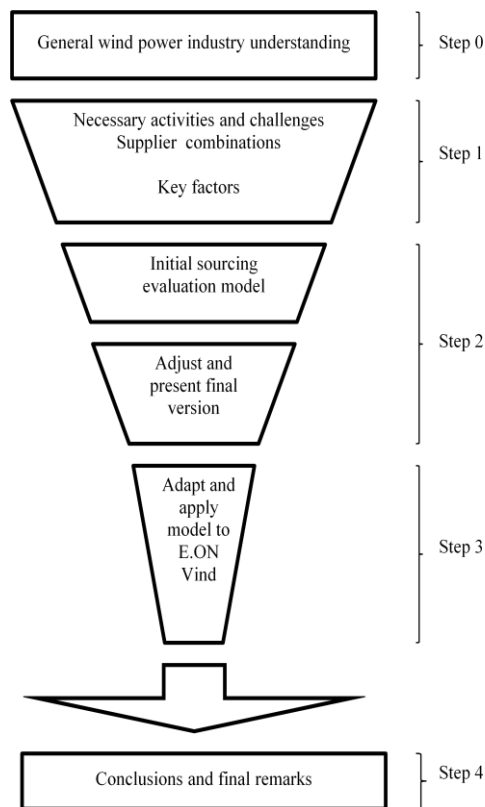


Figure 2. Work process

Chapter 4 will be the outcome of step 1, where the facts and key factors of WTG transportation and installations services are presented. The necessary activities for and the challenges associated with transportation and installation services of WTGs will be identified and described. Furthermore, possible supplier combinations for this type of service will be identified. Key factors that need to be taken into consideration when performing transportation and installation services of WTGs will finally be presented.

Step 2 will result in chapter 5 and 6. In the first of these chapters, an initial evaluation model for the procurement of transportation and installation services of WTGs will be created by combining the theoretical framework with the collected empirics. The adjustments performed before completing the final version of the evaluation model, will be presented in chapter 6.

Chapter 7 will constitute the outcome of step 3, where the completed evaluation model will be adapted and applied to the case company E.ON Vind. The model will first be adapted to E.ON Vind according to the company's values and prioritizations. Afterwards, the evaluation model will be applied to the Knäred project, where recommendations for a sourcing alternative will be given.

Finally, step 4 will result in chapter 8 where conclusions from earlier steps will be drawn, as well as final remarks.

2.2 Methodological approach

According to Arbner & Bjerke (1997) there are three methodological approaches in business research/consulting/investigation, namely the analytical, the systems and the actors approach²⁵.

Analytical approach

The analytical approach is based on the assumption that reality has a summative character; the whole is the sum of its parts. This means that once a researcher gets to know the different parts of the whole, the parts can be added together to get the total picture. Knowledge is characterized as being independent of its observers. Hence, knowledge advances by means of formal logic which is represented by specific judgments that are independent of individual subjective experience. These judgments consist of assumptions that can be verified or falsified. The results in the analytical view show pure cause-effect relations, logical models, and representative cases.²⁶

²⁵ Arbner & Bjerke (1997)

²⁶ Ibid.

Systems approach

The assumptions behind the systems approach is that reality is arranged in such a way that the whole differs from the sum of its parts. The relations between the parts are essential, and will lead to synergy effects. Knowledge is dependent on systems; the system approach explains or understands parts through the characteristics of the whole of which they are parts. With this approach the researcher is using existing system theories seeking to explain the finality relations. The results will be typical cases and classification mechanisms.²⁷

Actors approach

The actors approach focuses on that the whole is understood by the characteristics of its parts. The view is interested in understanding social wholes instead of explanations and the reality is taken as a social construction that is intentionally created by processes at different levels of meaning structures. Knowledge is dependent on actors, hence individuals. The researcher is using meta-theories and is trying to understand and describe the relation between the interpretations made by various actors. The relations explain how various interpretations mutually and in transformation influence each other in a continuous developmental process.²⁸

Chosen methodological approach

The systems approach will be used as the methodological approach for this thesis, where the system will be constituted by the manufacturing company; transportation, lift, installation of WTGs and the coordination between these activities and; the purchasing company. Each part must be put in a context to be understood. The structure of the different components will lead to synergy effects, which means that there is not only content in separate components. The parts in this thesis will all be combined and contribute to the creation of the evaluation model, where synergy effects between transportation and installation services of WTGs and the coordination of these activities arises and influence the choice of supplier and sourcing alternative.

The final result will consequently consist of parts that are analyzed comparable to the systems view, where the whole differs from the sum of its parts. In this situation the whole exceeds the sum of the parts, and in order to gain understanding of a certain situation a holistic perspective is necessary.

The analytical view will not be used in this study because of its focus on choosing the optimal parts, instead of taking the whole into consideration. Neither will the actors view be used, since the knowledge is not dependent solely on individuals.

²⁷ Arbnor & Bjerke (1997)

²⁸ Ibid.

2.3 Research strategies

There are four potential research strategies; *survey*, *case study*, *experiment* and *action research*. By using several types of research strategies, several types of data or several persons studying an object, a more comprehensive image of the study can be obtained. This is called triangulation.²⁹

A *survey* is characterized by compiling and describing the present of the studied object or phenomenon, which often is a broad question. A sample has to be made if the investigated population is too large, and from these answers conclusions concerning the entire population can be made.³⁰ *Case studies* aim to profoundly examine one or several cases, where influence on the studied object is minimized. No claims on generalizable results are made and even though series of case studies show a general pattern, the results can never be statistically proven. This type of study can, on the other hand, provide in-depth knowledge, through for example interviews, observations and/or archive analysis.³¹ A comparative analysis of several alternatives, where a few factors are isolated and one of them is manipulated, is called an *experiment*. This is done in order to find causality and explain the dependency between different phenomena.³² Lastly, *action research* is a closely monitored and documented study of an activity which aims to solve a problem while improving it at the same time. This type of research starts with an observation of a situation or a phenomenon, then a solution is proposed and finally, an evaluation of the solution is performed.³³

Chosen research strategy

A case study will be performed in order to describe the organization of transportation and installation services of WTGs, the possible supplier combinations and the key factors influencing the choice of supplier for this service. This information, in combination with the chosen theoretical framework, will constitute the foundation for the generally developed evaluation model. Moreover, an additional case study will be performed by testing the model on the Knäred project, where the developed evaluation model is adapted and applied to E.ON Vind Sverige AB.

2.4 Collecting data

There are two main techniques of gathering data; *primary* and *secondary* information. Primary data is collected by the researcher and can be collected through direct observations, interviews and experiments. Secondary data is to be

²⁹ Robson (2002)

³⁰ Rosengren & Arvidson (2002)

³¹ Yin (1994)

³² Montgomery (2005)

³³ Bergman & Klefsjö (2002)

found in existing documentation.³⁴ With the use of secondary information a problem often arises. The previously collected data might have been collected for another purpose, resulting in a difficulty of validating the quality and the usefulness of the data.³⁵

According to Yin (1994) there are six ways to collect evidence when performing case studies; *documentation, archival records, interviews, direct observations, participant-observation* and *physical artifacts*. These sources are complementary and should, with advantage, be used together. Although, the procedures for collecting each type of evidence must be developed and mastered independently to ensure that each source is correctly used.³⁶

Documentation

There are several types of documentation, e.g. letters, agendas, administrative documents or newspapers. The most important use of documents is to corroborate and augment evidence from other sources. Every document has been written for a different purpose and target audience than that of the case study being conducted. Hence, it is of importance to be aware of the fact that these documents do not contain the unmitigated truth.³⁷

Archival records

Examples of archival records include the following: service records, organizational records, maps and charts, lists, survey data and personal records. Compared to documentation, some archival records might be of such significance that they can become the object of extensive retrieval and quantitative analysis. Nevertheless, most archival records are produced for a specific purpose and a specific target group, which must be appreciated when interpreting the usefulness and accuracy.³⁸

Interviews

Interviews are the primary used method within qualitative research, where unstructured and semi-structured interviews constitute the most important forms. When performing unstructured interviews, relatively vague notes are used as support when reviewing the different themes of the interview, which makes it comparable to a regular conversation. Semi-structured interviews handle comparatively specific themes that will be affected, often entitled interview guide, and the respondent can freely formulate the answers. The interview process in both forms described is considered to be flexible. Emphasis should be on how the

³⁴ Lekvall & Wahlbin (2009)

³⁵ Arbnor & Bjerke (1997)

³⁶ Yin (1994)

³⁷ Ibid.

³⁸ Ibid.

respondent perceives issues and events and an understanding of patterns, events and behaviors.³⁹

According to Lekvall & Wahlbin there are four ways to communicate with the respondent, namely *written survey*, *personal interview*, *telephone interview* and *interview via Internet*. In a *written survey*, the questions are asked and answered on a questionnaire which is distributed and returned between the inquirer and the respondent without any intermediation from an interviewer. The great advantages of the *personal interview* are the unlimited possibilities to ask any type of questions and the opportunity to make the interview thorough and extensive. The questions are asked and answered orally and/or written at a personal encounter. However, problems can occur while trying to schedule an interview with respondents within a company – the so called access problem. In a *telephone interview*, the questions are asked by an interviewer and answered orally during a telephone conversation. *Interviews via Internet* is a new way of performing interviews. It is primarily used in the following three forms; through distribution and collection of written formularies via email; by posting the questionnaire on a website and then via email urge the contemplated respondents to answer; or through so called Internet panels, i.e. interviews via Internet with a sample of respondents.⁴⁰

Direct observations

By making a field visit to the case study “site”, an opportunity for direct observations is created. The observations can range from formal (observational protocols or measurement of the incidence of certain types of behaviors) to casual (field visit) data collecting activities. To increase the reliability of a direct observation, a common procedure is to have more than one observer performing the observation.⁴¹

Participants-observation

In participants-observations the observer is not just passively observing, but can adopt different roles within the case study situation and even participate in the events being studied. This type of observation can provide unusual opportunities for collecting data, such as the ability to gain access to events/groups that are otherwise inaccessible to scientific investigation. There are also problems related to participants-observation, where the investigator’s non-ability to work as an external observer is one example.⁴²

³⁹ Bryman & Bell (2005)

⁴⁰ Lekvall & Wahlbin (2009)

⁴¹ Yin (1994)

⁴² Ibid.

Physical artifacts

The final source of evidence is a physical or cultural artifact, which can be a technological device, a tool or instrument, or some other physical evidence. These have less potential relevance in the most typical kind of case study, but can however be an overall important component in the overall case.⁴³

Chosen data collection method

Primary data will be collected primarily through interviews. Semi-structured interviews will be performed with relevant respondents within the area, such as the manufacturing companies, the purchasing companies and the subcontractors. This method is chosen because of its ability to organize the interviews around certain themes. The answers are then more likely to be homogenous and therefore applicable in the analysis. Interviews will be performed in order to identify relevant key factors in the evaluation model, to clarify necessary adjustments to the evaluation model and finally to collect information concerning the case study.

Personal interviews will be conducted as far as possible, but might cause problems if interviews need to be performed with people in different parts of the country or abroad. Hence, telephone interviews with complementary questions over the Internet will also be used. In some cases, where the interviewee have limited time to offer over the telephone, written formularies will be distributed and collected via email. An initial contact will nevertheless be established over the telephone firstly. The interviews will, with the interviewees' permission, be recorded in order to minimize possible information loss. In order to secure the accuracy of the collected information, the interviewees will be asked to confirm the printed information.

Interviews will be complemented by different types of conversations and discussions. Oral, telephone and email conversations will be performed in order to verify information and when the authors have additional questions after completing the personal interview. Discussions will be held when a decision involving more than one person must be taken.

Direct observations, in the form of field visits, will be performed in order to gain a deeper understanding of the issue of study. These observations will be documented through notes and photographs. Since the authors will be spending time writing in the office of the case company, some participants-observations are inevitable.

Secondary data will be collected from documentation in order to gain understanding of the business. Documentation such as newspaper articles and reports will for example be used in the early stages of the work process in order to

⁴³ Yin (1994)

get a broad knowledge about the development of wind power worldwide. Reports and homepages relating to wind power, such as public tenders and company homepages, will be studied. Internal documents will in later stages also be used for more detailed information about the case company, its core processes and its suppliers.

Outcome

A total of 14 personal interviews have been held, mostly with the case company E.ON Vind. Telephone interviews have been held with four different manufacturing companies, and the six email interviews held were mainly with sub contractors. These interviews have been complemented with conversations where seven were held face to face, three by telephone and four by email. A discussion has also been held with employees at E.ON Vind, since a result based on several opinions was needed.

The authors initially intended to perform as many personal interviews as possible. However, the outcome shows that a variety of interviews have been performed; personal, by telephone and email. As noted above, the interviews can be related to the different stakeholder groups. This is mainly due to the fact that E.ON Vind have been easily accessible since they have been the case company. Most purchasing and manufacturing companies have offices in Sweden, although not geographically suitable for a visit. Therefore, telephone interviews have, to a large extent, been held with this group. The in depth and large amount of questions asked to the sub contractors ruled out telephone interviews. Due to their geographical location, personal interviews were impossible to perform. Consequently, contact was initiated via telephone and questionnaires were then sent out via email. The authors do not believe that the results of this thesis have been affected in a negative way by this outcome.

A field visit was conducted at the project site of Lilla Edet, north of Gothenburg. During this direct observation the authors gathered basic knowledge, creating an understanding of the wind power industry.

2.5 Research method

Two different research methods are usually acknowledged; qualitative or quantitative method. The choice of research method should be based on the character of the collected data.⁴⁴

The *qualitative method* aims to collect information, through for example interviews and observations, to gain a deeper understanding of the problem

⁴⁴ Bryman & Bell (2005)

studied. The main emphasis when collecting and analyzing data, which occurs simultaneously and interactively, are words rather than quantification.⁴⁵

The *quantitative method* is defined as a systematically collection of empirical and quantitative data, i.e. data that is represented by terms of quantity and numerical values.⁴⁶ This is followed by a statistical summary and an analysis of the outcome based on testable hypothesis. A representative sample is examined through measuring instruments, which capture connections, allocations and variations in the studied object.⁴⁷

Chosen research method

The qualitative research method is used in this thesis in order to gain a deeper understanding of the wind power business and the procurement process of transportation and installation services for WTGs. This information constitutes the foundation of the created evaluation model, which also will be applied to the case company.

2.6 Scientific reasoning

A research approach is defined as the path of conscious scientific reasoning. In Western research, there are two general approaches that may result in the acquisition of new knowledge, namely the deductive and inductive research approaches. A third approach, the abductive, combines the two approaches just mentioned.⁴⁸

Deductive reasoning is defined as a theory testing process, which starts with an established theory or generalization. It then seeks to test whether the theory applies to specific instances or not. General conclusions are presented based on the correctness of the hypothesis or propositions through empirical tests. Deductive research develops hypothesis or propositions before the testing and generalizing the results. These generalizations and their discussion with regards to prior knowledge constitute the new knowledge.⁴⁹

The gathering of information and empirics is the starting point of inductive research. Since induction aims at developing, not testing, theory, there is a subsequent construction of theories based on the information from the gathered data. The inductive research process is sometimes described as the mirror image of the deductive process.⁵⁰

⁴⁵ Bryman & Bell (2005)

⁴⁶ Ibid.

⁴⁷ Nationalencyklopedin (www)

⁴⁸ Spens & Kovács (2005)

⁴⁹ Ibid.

⁵⁰ Ibid.

The abductive approach offers a way of looping between theory and empirics, meaning that theories are used for empirical observations. The researcher initiates a creative iterative process in order to find a possible matching framework or to extend the theory used prior to this observation. When deliberately choosing the abductive process, the researcher applies a new theory or framework to an already existing phenomenon.⁵¹

Chosen approach

The approach of this study is abductive, since looping between theory and empirics frequently will occur. The work process will consequently change over time, depending on the outcome of the different steps. An additional aspect that supports the decision is the fact that a new framework will be applied to an already existing phenomenon.

2.7 Credibility

Credibility can be categorized in three different areas; *validity*, *reliability* and *generalizability*. Validity implies that the selected research method is measuring what it is intended to measure.⁵² Reliability refers to the trustworthiness – whether the results, based on interviews and surveys, will be identical at repetition, or whether they are affected by random assumptions⁵³. Within science, generalizability is the expansion of a theory/model with the purpose of making it applicable under broader terms⁵⁴.

A high validity will be achieved by using several different sources of data and clear, unbiased interview questions. It will also be accommodated through a distinct definition of the concepts used and through accurate planning. The reliability will be guaranteed by explicit interview questions, and as standardized measuring methods as possible. By compiling information from interviews and present this to the respondents, a safe position of the content will be done and increase the reliability. Generalizability will be accomplished by adjusting the developed evaluation model based on feedback from people working within various industries – not only the wind power industry.

2.8 Criticism of the sources

The authors will focus on interviewing stakeholders within the wind power industry, such as manufacturing companies, wind power companies and sub contractors within the transport and installation industry. Therefore, opinions from other stakeholders, for example companies involved in complex construction

⁵¹ Spens & Kovács (2005)

⁵² Lekvall & Wahlbin (2009)

⁵³ Bryman & Bell (2005)

⁵⁴ Wallén (1996)

projects, which might be affected, will not be equally emphasized. Cases of subjectivity in the interviews are anticipated, since the respondents' answers will be colored by their perception of reality. Hopefully, this will be minimized by adapting the questions in the interview, in order to get as generalizable answers as possible. Since the issue of study in this thesis is quite new in the industry (all of the purchasing companies that the authors have been in contact with, purchase transportation and installation services directly from the manufacturing company), there might be other key factors that need to be taken into consideration. These will only appear following evaluation of the model, after testing it on a real project.

Due to a limited timeframe it will be impossible to get in contact with all the manufacturing companies, purchasing companies and subcontractors in the studied segment. Therefore, focus will be to converse with the companies' active in the region (Scandinavia and Germany foremost) which will have an impact of the content of the evaluation model. However, the procedure of transportation, lift and installation of WTGs is similar worldwide, except that there might be some other means of transportation and the risk of ice is not applicable to the warmer countries.

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3. Theoretical framework

The third chapter presents the theoretical framework used in this thesis. Initially, the specifics of logistics services are presented. An introduction to different sourcing alternatives, sourcing options and supplier combinations is given. Thereafter, Multiple Criteria Decision Analysis, the multiple criteria problem, the construction of a qualitative value scale and supplier selection criteria are reviewed. Lastly, collaborative transportation management and cost-benefit analysis are presented.

3.1 Logistics services

New logistics demands, and a changing context, will have impact on the buying process for logistics services and new procurement situations are likely to occur. It is therefore important to understand what new resources, routines and competence the companies need to have in order to purchase logistics services in an effective way.⁵⁵

Services differ from goods since they are intangible, not standardized, inseparable, and perishable. Logistics services mainly involve business-to-business relationships with an increased need for close interaction and are performed in the interface between shippers and customers.⁵⁶ Services impact customer satisfaction directly⁵⁷. The degree of complexity is influenced by the number of services included, the tangibility of the services, whether focus is on handling or value adding, execution of activities or management, and if the service is pre-defined and stable or if development and re-engineering is a part of the scope.⁵⁸

Purchasing strategies should standardize the services bought, use global sourcing and competitive bidding, and consolidate the services to only a few providers. This will help companies to achieve economies of scale and to reduce transaction costs. When focusing on agility and core competence, it leads to outsourcing of more advanced services to systems/solutions providers. When outsourcing, the company spread their risks and concentrate on issues critical to survival and future growth.⁵⁹

An increasing number of companies obtain their competitive advantages through creating successful logistics outsourcing alliances to optimize value and performance. Modern logistics services industry is moving towards the direction

⁵⁵ Andersson & Norrman (2002)

⁵⁶ Ibid.

⁵⁷ McDougall & Levesque (2000)

⁵⁸ Andersson & Norrman (2002)

⁵⁹ Ibid.

of globalization and networking. Aspects that now are important to take into consideration are the reduced risk sharing, and the strategic flexibility.⁶⁰

3.2 Sourcing alternatives

Sourcing decisions are influenced by economic considerations, both costs and benefits, and may also be influenced by power of supplier and buyer, risk and social/behavior aspects. The outcomes will be affected by contingencies, such as the good/service, the buying organization and buyer's policy.⁶¹ As stated earlier, a sourcing strategy describes what type of relationships to pursue, and how many suppliers the company should concern when it comes to buying decisions. By studying different sourcing options and supplier combinations, it is easier for companies to create an appropriate strategy.⁶²

3.2.1 Sourcing options

An organization's profit is, to a large extent, determined and defined by its purchases, and purchasing has been considered one of the key drivers for a company's survival and growth. One of the purchasing department's major responsibilities is sourcing or selection of suppliers.⁶³

Sourcing can be defined as the strategic philosophy of selecting vendors in a manner that makes them an integral part of the buying firm for a particular component/part/service they are to supply. This definition pinpoints the profound meaning of sourcing that is beyond the traditional view. In other words, sourcing no longer simply refers to getting raw material at desired prices. The decision should instead be incorporated into the buying firms operating strategies to support, or even to improve, the firm's competitive advantages.⁶⁴

As sourcing plays an important role in a firm's competitiveness and growth, it is necessary to study and understand different sourcing alternatives⁶⁵. Below, the alternatives of single and multiple sourcing are presented.

Single sourcing

Single sourcing refers to the situation in which a company within a certain category with clear intent buys from just one supplier, even though other comparable suppliers exist in the supplier base. In the past, industries, especially in the western countries, have typically dealt with multiple suppliers. However, the trend has now begun to move towards a reduction of suppliers. To accomplish

⁶⁰ Liu & Cui (2006)

⁶¹ Quayle (1998b)

⁶² van Weele (2005)

⁶³ Zeng (2000)

⁶⁴ Zenz (1994)

⁶⁵ Zeng (2000)

this task a manufacturing facility must maintain an excellent working relationship with its suppliers. Once the supplier and manufacturer begin working together and a long-term commitment is established, there is no need for additional suppliers. This has led to the idea of single sourcing.⁶⁶

When the supplier's availability of technical support, the reliability of the product, and the total cost of the product are emphasized, single sourcing is normally chosen as the purchasing method.⁶⁷

A detailed comparative analysis of single and multiple sourcing practices has revealed that the key distinction between these two sourcing methods lies in the areas of quality control, lot size, delivery frequency, and the term of contract.⁶⁸

Multiple sourcing

Multiple sourcing is the situation in which a company within a certain category buys from more than one supplier. In this approach, each supplier responds to the demands and specifications from the buying company. This purchasing method plays one supplier against another and the competition between the suppliers is intense.⁶⁹

The consequences of this strategy include a large base of suppliers and very short duration contracts. From the suppliers' point of view, they have the burden of being responsible for maintaining the necessary technology, expertise, and forecasting abilities plus cost, quality, and delivery competencies. For the buyer, dealing with several suppliers may require a longer time in negotiation and in return, may delay or disturb the buyer's production schedules.⁷⁰

The many-supplier approach is a traditional sourcing method and places the emphasis on achieving the lowest possible price for a particular product. If the long-term partnership is not the goal of the buying firm and the initial price is more important than the total price of a product, then multiple sourcing is a preferable and suitable purchasing alternative.⁷¹

3.2.2 Supplier combinations

There are several alternatives concerning supplier combinations and these differ between projects. Specific project factors, such as the experience and resources

⁶⁶ Zeng (2000)

⁶⁷ Ibid.

⁶⁸ Ibid.

⁶⁹ Ibid.

⁷⁰ Ibid.

⁷¹ Ibid.

available, the project time table, the scope of the project, and the local conditions, may influence the decision of which approach to be used.⁷²

Transaction cost economics have been established to help companies view their boundary decisions, whether to conduct an activity internally or externally⁷³. It is the interaction of efficiency, appropriability and competition concerns that drive the decision whether to make-only, make-plus-buy or buy-only⁷⁴. These options are presented further below, where they are referred to as make yourself (make-only), make and buy (make-plus-buy) and turnkey solutions (buy-only).

Make yourself

When producing something in-house, the firm better understands the good or service and takes advantage of their own expertise. Make yourself can be viewed as internal sourcing, since resources within the company is utilized. There are different logics behind choosing internal sourcing; to protect the company against supplier opportunism; to better coordinate and adapt; to align incentives by using authority; to gain better flexibility and; to better specify and evaluate projects.⁷⁵

The advantages of making in-house only arise if the company has the resources and knowledge needed for the execution of the specific project. Otherwise, a turnkey solution is preferable to use. Theories suggest companies to conduct competence-related activities in-house and to outsource other activities.⁷⁶

Make and buy

Firms can simultaneously make and buy goods and services at the same time, which is called institute concurrent sourcing⁷⁷. Companies engage in concurrent sourcing to acquire knowledge about production costs, in order to improve their bargaining position when negotiating with an outside provider. It is a strategic insight when and how horizontal competitors might benefit from collaboration, and managing the tension between competition and cooperation.⁷⁸

Turnkey solutions

There are different turnkey alternatives available to the project owner of the execution process. These options are ranged from one extreme, where one contractor takes full responsibility for the execution (full turnkey) to another extreme, where the owner takes full control of the execution (multiple contracting). Between these two extremes there are a number of other execution

⁷² Ireland (2000a)

⁷³ Parmigiani (2007)

⁷⁴ He & Nickerson (2006)

⁷⁵ Parmigiani (2007)

⁷⁶ Ibid.

⁷⁷ Ibid.

⁷⁸ He & Nickerson (2006)

approaches, in which the risk is shared between the owner and the contractors in varying proportions, see Figure 3 below.⁷⁹

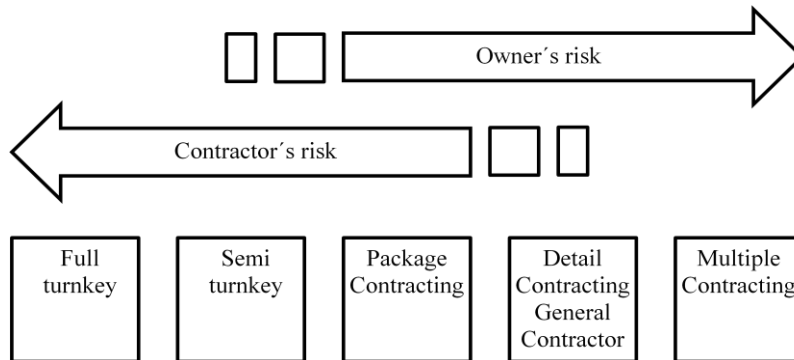


Figure 3. Alternative project execution approaches⁸⁰

A *full turnkey* solution means that a single contractor acquires and sets up all premises, equipment, supplies and operating personnel to bring a project to operational readiness. This solution is appropriate for customers unable to perform, or who wish to avoid, their own subcontracting. The principal advantages of full turnkey solutions are that the contract lies with a single source and the client is relieved from responsibilities for the performance and the equipment used.⁸¹

When using *semi turnkey*, one or several civil contractors are responsible for the execution of all civil works for the plant, infrastructure and to provide warranties⁸². The purchasing company is mainly responsible for the coordination between the main contractor and the civil contractors⁸³.

Package contracting means that several contractors are responsible for the detail engineering, procurement, and quality control. Each contractor is responsible for the performance guarantees and warranty of their package. One or several civil contractors are responsible for the execution of all civil works for the plant and infrastructure. The buyer is mainly responsible for the specification and procurement of the transportation, scheduling, and coordination.⁸⁴

When using *general contractors*, they are responsible for all construction activities, such as execution of civil construction, mechanical erection, and electrical installation. Depending on the contracting mode, the general contractor

⁷⁹ Ireland (2000a)

⁸⁰ Ireland (2000b)

⁸¹ Ireland (2000a)

⁸² Ibid.

⁸³ Merna & Smith (1990)

⁸⁴ Ireland (2000a)

can be held responsible for all or parts of the detail design. In some cases, the general contractor can also provide procurement services for secondary or auxiliary equipment.⁸⁵

Using *multiple contracting*, the buyer develops the process concept, prepares the basic design of the project and specifies and procures all equipment. The buyer is for example responsible for training of personnel and permitting and dealing with local authorities. Several contractors are responsible for the execution of civil construction, mechanical erection and electrical installation for their respective scope of work.⁸⁶

The risk concerning responsibility varies between the contractor and the owner, depending on chosen turnkey solution. When using a full turnkey solution the contract should protect the purchasing company (owner) against late completion, poor quality and cost overruns. However, a multiple contracting solution has a higher owner risk, with a higher risk of budget overruns and a requirement of full involvement from the owner. The variation between the owner and contractors risk is illustrated in Figure 3.⁸⁷

3.3 Multiple Criteria Decision Analysis (MCDA)

Every decision made require the balancing of multiple factors, which sometimes happen explicitly and sometimes without a conscious thought. When confronted with choices that matter where the consequences are substantial, impacts are long term and may affect many people, and mistakes might not easily be remedied, it can be helpful to utilize a tool. The nature of multiple criteria problems is that there is much information of a complex and conflicting nature, often reflecting differing viewpoints and often changing with time. One of the principal aims of MCDA approaches is to help decision makers to organize and synthesize such information in a way which leads them to feel comfortable and confident about making the decision. It also minimizes the feeling of post-decision regret, since all necessary criteria or factors have properly been taken into account. The models used provide a focus and a language for discussion, where the most useful approaches are conceptually simple and transparent.⁸⁸

Hence, MCDA is an aid to decision making, a process which seeks to integrate objective measurement with value judgement and make explicit and manage subjectivity. Subjectivity is something that is inherent in all decision making, in particular in the choice of criteria on which to base the decision, and the relative weight given to those criteria. MCDA does not eliminate that subjectivity; it seeks

⁸⁵ Ireland (2000a)

⁸⁶ Ibid.

⁸⁷ Ibid.

⁸⁸ Belton & Stewart (2002a)

to make the need for subjective judgements explicit and the process by which they are taken into account transparent. The process leads to better considered, justifiable, and explainable decisions.⁸⁹

Figure 4 below shows Belton & Stewart's (2002) main stages of the process from the identification of a problem to the development of an action plan. The action plan can take on many forms such as recommendations or procedures.⁹⁰

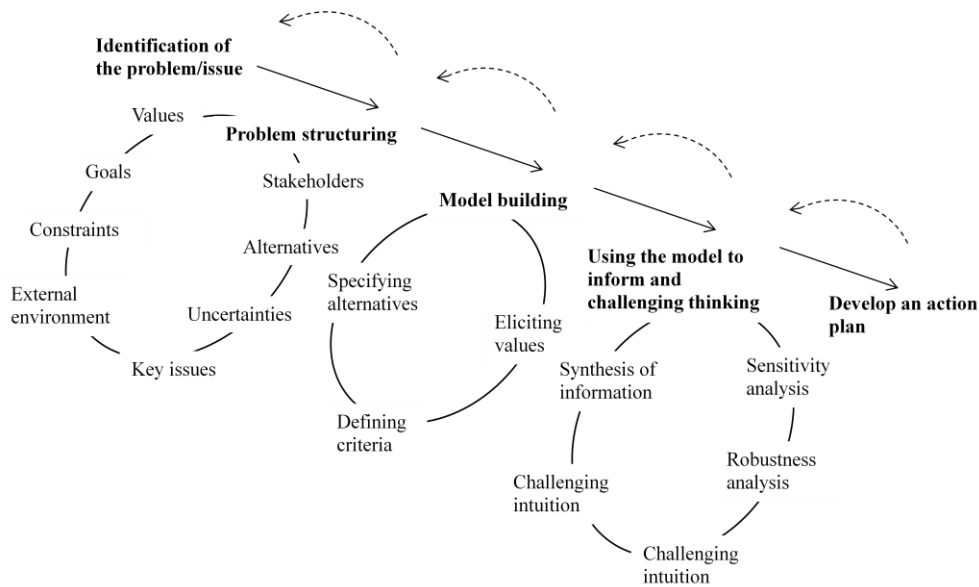


Figure 4. The process of MCDA⁹¹

The initial structuring phase is one of divergent thinking; opening up the issue, surfacing and capturing the complexity and beginning to manage this. The phase also deals with the understanding of how the decision makers can move forward. The model building and usage phase represent a more convergent mode of thinking. It is a process of extracting the essence of the issue from complex representation, in a way which supports a more detailed and precise evaluation of potential ways to move forward. The outcome of these phases might be a need to think creatively about other options or aspects of the issue. Iteration within and between the key phases of the process can be expected.⁹²

⁸⁹ Belton & Stewart (2002a)

⁹⁰ Ibid.

⁹¹ Belton & Stewart (2002b)

⁹² Belton & Stewart (2002a)

3.3.1 The multiple criteria problem

There are four different major problematiques, identified by Roy (1996)⁹³, for which MCDA may be useful:

- **The choice problematique:** To make a simple choice from a set of alternatives.
- **The sorting problematique:** To sort actions into classes or categories, such as “definitely acceptable”, “possibly acceptable but needing more information”, and “definitely unacceptable”.
- **The ranking problematique:** To place actions in some form of preference ordering which might not necessarily be complete.
- **The description problematique:** To describe actions and their consequences in a formalized and systematic manner, so that decision makers can evaluate these actions. It is a learning problematique, in which the decision maker seeks simply to gain greater understanding of what may or may not be achievable.⁹⁴

3.3.2 Constructing a qualitative value scale

When constructing an appropriate qualitative scale it is necessary to define at least two points on the scale, usually called the end points. Intermediate points may also be determined and defined descriptively. An approach is to associate specific alternatives, with which the decision makers are familiar, with points on the scale.⁹⁵

Qualitative scales have the following characteristics:

- **Operational:** Allows the decision makers to rate alternatives not used in the definition of the scale.
- **Reliable:** Two independent ratings of an alternative should lead to the same score.
- **Value relevant:** Relates to the decision makers’ objective.
- **Justifiable:** An independent observer should be convinced that the scale is reasonable.⁹⁶

3.4 Supplier selection criteria

The supplier selection and management system

The supplier selection and management system (SSMS) is an evaluation model for manufacturing companies that includes the steps of choosing supplier

⁹³ Roy (1996)

⁹⁴ Belton & Stewart (2002a)

⁹⁵ Ibid.

⁹⁶ Ibid.

selection system, supplier management system, and purchasing strategy system, as illustrated in Figure 5 below.⁹⁷

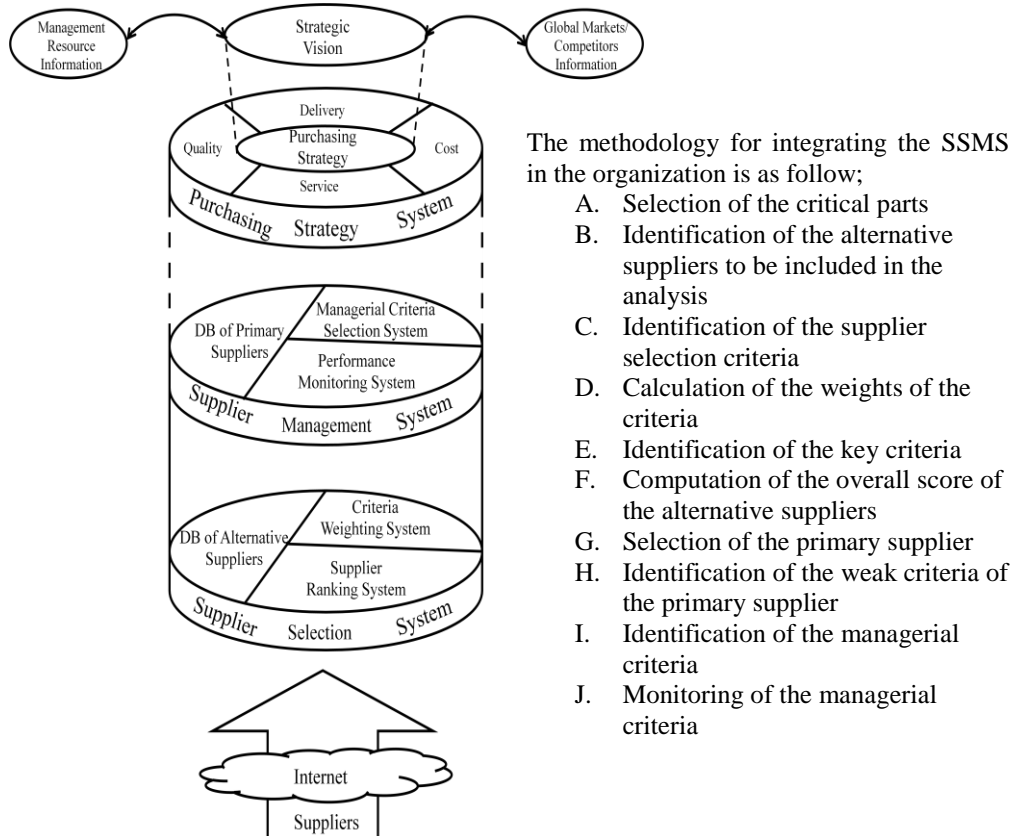


Figure 5. Framework and methodology for performing an SSMS analysis⁹⁸

The procedure for SSMS is to present a managerial guideline for the supplier selection and management, based on manufacturer-supplier partnership. The framework identifies the managerial criteria using information derived from supplier selection process and makes use of them in the supplier management process. These managerial criteria include key criteria that are the major criteria required by the purchasing company in order to achieve the best quality from the suppliers. It also includes weak criteria that show the shortcomings of selected suppliers compared with alternative suppliers, with regards to each criterion. The SSMS calculates the weights of tangible and intangible criteria for supplier selection and rank the suppliers' performance. The weights of the criteria are applied to select the key criteria to assure the quality of each project.⁹⁹

⁹⁷ Lee, Ha & Kim (2001a)

⁹⁸ Lee, Ha & Kim (2001b)

⁹⁹ Lee, Ha & Kim (2001a)

Summarizing supplier evaluation criteria

Supplier differentiation can be defined as the identification of differences between some of the characteristics of suppliers, such as organizational culture, production processes, technical capability, and geographic distribution. Supply chain performance can be viewed as sustained effective activity over past, present, and future periods. The question of what would constitute an effective and efficient supply chain performance evaluation method is becoming an increasingly important topic in supply chain discussions.¹⁰⁰

Below a summary of how supplier evaluation criteria within manufacturing companies have evolved over the years is presented, see Table 1. The criteria presented by Dickson (1966) still cover the majority of the criteria presented in the literature today, although the industrial environment has modified the degrees of its relative importance¹⁰¹.

Table 1. Summarized supplier evaluation criteria, manufacturing companies

Author (year)	Evaluation criteria	Area
Dickson (1966)	Quality; price; delivery; performance history; warranties and claims policies; production facilities and capacity; technical capability; financial position; procedural compliance; communication system; position and controls; repair service; attitude; impression; packaging capability; labor relations record; geographical location; amount of past business; training aids; and reciprocal arrangements	General vendor selection
Cusumano & Takeishi (1991)	Financial matters; price; quality; delivery; technical capability; and past business relationship	Automobile manufacturers in the United States and Japan
Weber & Current (1993)	Price; delivery dependability; and product quality	General vendor selection
Chaudhry, Frost & Zydiak (1993)	Quality; delivery capability; and price breaks	General vendor selection

¹⁰⁰ Shih, Hung & Lin (2009)

¹⁰¹ Benyoucef, Ding & Xie (2003)

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Choi & Hartley (1996)	Financial matters; consistency; relationship; flexibility; technical capability; service; reliability; and price	Automobile industry in the United States
Jayaraman, Srivastava & Benton (1999)	Quality; nature of products; lead time; and warehousing capability	General vendor selection
Lee, Ha & Kim (2001)	Costs; quality; delivery; and service	General vendor selection
Muralidharan, Anantharaman & Deshmukh (2001)	Quality; technical capability; and delivery	General vendor rating
Muralidharan, Anantharaman & Deshmukh (2002)	Quality policy; delivery time; price; professional and technical expertise; financial condition; past performance; equipment; flexibility; and service	General vendor selection
Prahinski & Benton (2004)	Quality; delivery performance; price; ability to respond to changed needs; and support services	Automotive suppliers in the United States
Kreng & Wang (2005)	Costs; quality; delivery reliability; lead time; and timeliness of delivery	General vendor selection
Pi & Low (2005)	Quality; timeliness of delivery; price; and service	General vendor selection
Chang, Wang & Wang (2007)	R&D capability; costs; quality; service; and responsiveness	General vendor selection
Kuo, Wang & Tien (2010)	Corporate social responsibility; delivery; quality; service; cost; and environment	Green supply chain management

3.5 Collaborative transportation management

Collaborative transportation management (CTM) involves information and process flows, whereby suppliers and buyers collaborate jointly with carriers or 3PLs¹⁰². It is defined as a holistic process that brings together supply chain trading partners and service providers to address inefficiencies within the transport planning and execution process¹⁰³. The objective is to improve the operating

¹⁰² Sutherland (2003)

¹⁰³ Yuan & Shon (2008)

performance of all parties involved in the relationship by reducing or eliminating inefficiencies in the transportation process¹⁰⁴.

Successful collaboration is a function of how well people work together both internally and with collaboration partners. The following enablers are related to the human side of CTM:

- Common interest
- Openness
- Recognizing who and what is important
- Clear expectations
- Leadership
- Cooperation, not punishment
- Trust
- Benefit sharing
- Advanced information technology¹⁰⁵

The implementation of CTM requires systems that enable inter organizational collaboration in a cost-effective and technologically compatible manner. The enabling and supporting role of information technology to CTM processes can only be realized if the technology is employed effectively.¹⁰⁶

3.6 Cost-benefit analysis

The cost-benefit analysis is a method for analyzing projects for investment purposes. The method consists of the following three steps:

1. Identify the financial value of expected project cost and benefit variables.
2. Analyze the relationship between expected costs and benefits using simple or sophisticated selection techniques.
3. Make the investment decision.¹⁰⁷

Benefits are defined as net willingness to pay and costs include real resource costs. A cost-benefit analysis often focuses on identifying economically efficient projects and ranking projects after both their levels of economic efficiency and equity.¹⁰⁸

There are several approaches to weighting benefits and costs based on appropriate criteria. One of the easiest ways to account for distributional issues is to display the benefits and costs disaggregated by what is relevant for the typical project, i.e. a stakeholder approach.¹⁰⁹ The cost-benefit concept suggests that a money value

¹⁰⁴ Sutherland (2003)

¹⁰⁵ Sutherland (2006)

¹⁰⁶ Sutherland (2003)

¹⁰⁷ Rajanen (2003)

¹⁰⁸ Loomis (2011)

¹⁰⁹ Ibid.

can be put on all the costs and benefits of a strategy, including tangible and intangible returns. Its major benefits are in forcing managers to be explicit about the various factors that influence strategic choice.¹¹⁰ Quantitative comparisons of the distributional consequences can also be made to formalize comparisons of distributional effects across the cost-benefit analysis alternatives.¹¹¹

3.7 Linking the theoretical framework to the study

The theoretical framework presented in this chapter will be used as follows. Theories regarding logistics services, sourcing alternatives and supplier combinations will reflect the design of the created evaluation model and provide general understanding of the problems that might arise when dealing with services. MCDA will constitute the foundation of the developed evaluation model and will be studied to ensure the quality and usefulness of it. SSMS is a MCDA model similar to created evaluation model and will work as an inspiration in the development of the approach/work flow. Theory regarding the value scale will be taken into consideration when developing the rating scale used in the model. General frameworks, such as CTM and cost-benefit analysis, will be used as a complement to the development of the evaluation model.

¹¹⁰ Johnson, Scholes & Whittington (2008)

¹¹¹ Loomis (2011)

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4. WTG transportation and installation services – facts and key factors

In this chapter, the collected information constituting a part of the foundation of the evaluation model is presented. Firstly, the makeup of a wind turbine is described and the necessary activities within a wind power project is recognized and reviewed. Possible turnkey solutions within the wind power industry are identified and key factors concerning transportation and installation services, derived from interviews and existing evaluation models, are recognized.

4.1 The size of a WTG

To understand and appreciate the logistics of transporting such massive parts it helps to understand the makeup of a wind turbine. The specifics below are for a Vestas V-90 2.0 MW turbine, and Figure 6 illustrates the different components:

- **The nacelle** is the size of a small motor home (4 meters high, 10.4 meters long and 3.4 meters wide) and weighs 70 tons.
- **Each blade** is 44 meters long and, including the 3-blade rotor, the total weight is 38 tons.
- **The 95-125 meter tower** is made up of rolled steel and comes in three pieces. The entire tower weighs between 205 and 335 tons.¹¹²
- **The foundation** has an area of around 400 square meters, with a depth varying from 1.20 to 3 meters.¹¹³
- **Swept area** of the blades is 6 362 square meters, which is equivalent to 4 NHL hockey rinks combined.
- **Total weight** of the entire turbine is 313-443 tons depending on the tower height.¹¹⁴

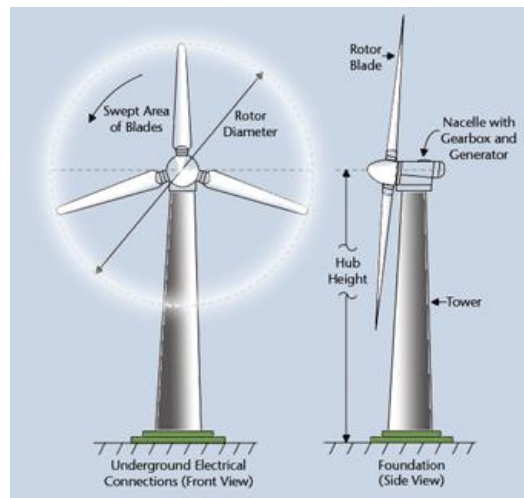


Figure 6. Wind turbine generator components¹¹⁵

¹¹² Vestas (2010)

¹¹³ Brännström, personal interview (2011b)

¹¹⁴ Vestas (2010)

¹¹⁵ Alternative Energy (www)

However, the wind turbine components can be even bigger than this¹¹⁶. A common effect of a modern WTG is between 2 and 3 MW, with a total height of 150-180 meters (including blades)¹¹⁷.

4.2 Necessary activities from factory to commissioned WTG

A WTG is divided into components, which are usually produced at factories in different countries. Therefore, a combination between different transportation alternatives and reloading points need to be considered which complicates the transportation of the WTGs.¹¹⁸ After the WTGs have been transported to the project site, the simultaneously occurring activities regarding lift and installation begin. During the entire process, from manufactured to commissioned WTGs, coordination is essential. It is important that all activities regarding transportation and installation services are coordinated to make the process as efficient as possible.¹¹⁹

The necessary activities identified from manufactured to commissioned WTG are hence *transportation*, *lift*, *installation* and *coordination*, which are presented below. Lift and installation are performed partially concurrently and usually by the same subcontractor¹²⁰, which is why these services are merged together and occasionally referred to as installation services.

4.2.1 Transporting WTGs

Understanding the size of wind turbines provides an appreciation for the complexity of their transportation. A single turbine can require up to 8 loads (one nacelle, one hub, three blades and three tower sections). For an entire project of 150 MW, transportation requirements have been as much as 689 truckloads, 140 railcars and 8 vessels to the United States. Many projects today are much larger than 150 MW.¹²¹ The complexity of the transportation leads to a need for road surveys, in order to ensure that the roads connected to the project site are wide enough and have the right buoyancy¹²².

Moving wind turbine components to a project site is not easy. It involves handling sensitive and expensive components that are both heavy and big. This requires extensive coordination, communication and scheduling between for example

¹¹⁶ CN North America's Railroad (2009)

¹¹⁷ Vindlov (www)

¹¹⁸ Bengtsson, personal interview (2011)

¹¹⁹ Egard, conversation (2011a)

¹²⁰ Ibid.

¹²¹ CN North America's Railroad (2009)

¹²² Lundsgård, personal interview (2011b); Bengtsson, personal interview (2011)

logistics providers, trucking companies, port operators, barge and ocean vessel owners.¹²³

The risk for delays and standstill during transportation is predominant. Delays can occur in the production of the wind turbine, which affects the transportation. Various accidents along the transportation route can also lead to delays in the time schedule, which accordingly lead to standstill at the project site. Weather conditions such as ice and snow can cause delays, foremost during transportation and reloading/offloading of the WTGs.¹²⁴ The different means of transportation used when a WTG is freighted are shown in Figure 7 below.



Figure 7. WTG transportation by truck, rail and sea¹²⁵

4.2.1.1 Transporting WTGs by truck

Trucks are almost always the last step in delivering turbine components to the project site, since most wind sites are not located right by the coast. It will most likely continue to be so, as project sites expand beyond populated areas.¹²⁶ Transportation of components for wind turbines that are tall, wide and heavy require dispensation in order to be allowed to freight on common roads, such as when and where these are permitted¹²⁷. In France, transportation by truck is forbidden which affects the overall coordination of the activity in Europe, since there are manufacturers with factories in Spain¹²⁸. According to Trafikverkets rules, transportation of wind turbines by truck in Sweden is allowed for 400 kilometers linear distance in 2011. In 2012 this distance will decrease to 350 kilometers and then kept constant. A special trial for sites containing two turbines, or less, can be applied for.¹²⁹

¹²³ CN North America's Railroad (2009)

¹²⁴ Bjarnegård, telephone interview (2011); Lundsgård, personal interview (2011b)

¹²⁵ Renewable Energy News Monitoring (www); Duluth Shipping News (www); Trafikverket (2010a)

¹²⁶ Ozment & Tremwel (2007)

¹²⁷ Trafikverket (2010b)

¹²⁸ Egard, conversation (2011a)

¹²⁹ Östman, telephone conversation (2011)

Truck transportation has several problems that increase costs and the problematic nature of on-road transport, but the convenience and ability of truck to access remote areas solidifies their importance in the wind energy supply chain¹³⁰. The challenges include a variety of permitting rules for oversized/overweight loads; driver shortages and training; tight carrier capacity and non-optimized loads/scheduling; rising fuel costs; and hours of service constraints¹³¹.

4.2.1.2 Transporting WTGs by rail

Rail is becoming a more popular mode of transport for wind turbine components, especially in the United States. However, there are drawbacks with rail which include timing and ability to meet schedules. Rail tends to be much slower than trucking. Also, there must be rail sidings (unloading points), as shown in Figure 8 to the right, close to the project location which may not always be the case. Advantages with rail travel in the United States is that it does not require as extensive permitting process compared to trucking, and heavier loads can be managed.¹³²



Figure 8. Unloading point¹³³

In Sweden, it is possible to freight wind turbine components by rail, but there are problems with the existing wagons. In order to transport for example the blades, wagons need to be manufactured or rebuilt.¹³⁴ There are also concerns regarding the limitations for rail transportation of long and bulky transport modules for wind turbines¹³⁵. Today, there are no existing unloading points. Transportation by rail from Europe is, just as in Sweden, dependent of the dimension of the wind turbine. Most countries in Europe have a smaller loading profile than Sweden does, which speaks against this solution. Regarding the differences in rail dimension between the European countries, there are either wagons with exchangeable wheels or a possibility to reload the cargo to a different wagon at the border station.¹³⁶

4.2.1.3 Transporting WTGs by sea

Transporting WTGs by sea is more common in Europe than in the United States. The main reason for this is higher accessibility and the possibility to reach larger areas by boat.¹³⁷ There are great opportunities for using Swedish harbors when

¹³⁰ Ozment & Tremwel (2007)

¹³¹ AWEA Wind Power (2009)

¹³² Badeusz, email conversation (2011)

¹³³ Progressive Rail (www)

¹³⁴ Vindkraft Norr (2008)

¹³⁵ Trafikverket (2010b)

¹³⁶ Wall, email conversation (2011)

¹³⁷ Rohwer, personal interview (2011)

transporting wind turbines. According to a report by WSP, the 10 harbors that have;

- handled wind turbines before
- sufficient lifting resources
- appealing connecting roads
- embankments and stock areas with sufficient buoyancy
- a possibility to accept large ships
- rail connection to the embankment and contemplated embankments and stock areas

are Copenhagen Malmö Port, Gävle Hamn AB, Halmstad Hamn och Stuveri AB, Luleå Hamn, Lysekils Hamn AB, Oskarshamn Hamn AB, Skellefteå Hamn, Uddevalla Hamnterminal AB, Umeå Hamn AB and Varberg/terminal West. The main reason why more harbors do not fulfill these criteria is the lack of sufficient lifting resources for this type of heavy lifting. However, mobile cranes can be rented to solve this problem.¹³⁸ Figure 9, to the right, illustrates a wind power tower being unloaded from a ship.



Figure 9. Component unloading¹³⁹

4.2.1.4 Challenges considering transportation of WTGs

While the market opportunities for transportation and logistics providers are growing there are challenges that, if left unaddressed, will create obstacles to achieving the wind energy industry's full potential. Companies that can address these challenges will be particularly sought after.¹⁴⁰

Among the key transportation and logistics challenges impacting all modes of transport are:

- Height, weight, width, and length limitations.
- The growing size and weight of wind turbine blades, towers and nacelles, which may exceed the physical capacity of existing equipment.
- The limited number of truck trailers capable of transporting turbine components.
- The growing transportation and logistics costs contributing to price pressures in wind energy development (such costs can add 10-25% to the cost of a turbine).¹⁴¹

¹³⁸ WSP Analys & Strategi (2009)

¹³⁹ Port of San Diego (www)

¹⁴⁰ AWEA Wind Power (2009)

¹⁴¹ Ibid.

4.2.2 Lift and installation of WTGs

Once transported to the project site, every WTG is installed on a foundation. On grounds with a normal character so called gravity foundations are established, which means that the WTG is mechanically assembled to the foundation and buried under ground. When installing a WTG on rocks, it is established with bolts that are clamped with concrete in deep holes in the bedrock.¹⁴² However, this is an unusual alternative within Sweden, since solid bedrock is necessary¹⁴³.

The WTGs are lifted by using mobile cranes, which may be either of crawler type or truck-mounted. Crawler cranes are often the preferred choice.¹⁴⁴ The two different types of cranes are presented in Figure 10 below.



Figure 10. Crawler and truck-mounted cranes¹⁴⁵

The bottom part of the tower is assembled to the foundation and the remaining tower sections are lifted and assembled with the assistance of installation personnel up in the tower. The nacelle is lifted on site and assembled. The blades are assembled to the nave either on the ground or one by one in the tower.¹⁴⁶

Cranes in general have benefits of a short installation time per turbine and a relatively small crew. Disadvantages are the areas needed for the lifting operation, need for wide roads inside parks, rigging between turbine sites, wind restrictions (maximum 5-8 m/s during lifting) and the cost for mobilization and hire, especially of the largest units.¹⁴⁷

The erection of a WTG is usually performed in a couple of days, as long as the wind conditions are favorable. Finally, it takes about a week to commission the

¹⁴² Stena Renewable (2009)

¹⁴³ Axelsson, personal interview (2011)

¹⁴⁴ Vindforsk, Energimyndigheten & Elforsk (2010)

¹⁴⁵ Liebherr (www)

¹⁴⁶ Stena Renewable (2009)

¹⁴⁷ Vindforsk, Energimyndigheten & Elforsk (2010)

WTG before the electricity production can commence. Since the WTGs are commissioned section wise, the commissioning of the entire wind park can take months.¹⁴⁸ Figure 11 below shows two situations where parts of the WTG are lifted.



Figure 11. Lifting of blade and nacelle¹⁴⁹

4.2.3 Coordinating the services of transportation, lift and installation

Coordination of transportation and installation services concerns managing interfaces, the contact between the different subcontractors on the project site and the overall security responsibility. The control situation differs depending on who is responsible for coordinating the construction for wind power projects.¹⁵⁰

The question regarding responsibility is tough and dependent of the number of subcontractors involved. It is therefore important to establish contracts handling these types of questions in order to eliminate disputes.¹⁵¹ The company responsible for coordinating transportation and installation services need to use for example incoterms to facilitate the responsibility distribution¹⁵². Incoterms are used to separate responsibilities and transaction costs between the buyer and the provider and they reflect state of the art transportation practices¹⁵³.

4.3 Turnkey solutions within the wind power industry

When focusing on appropriate turnkey solutions within the wind power industry there are two options that reflect the acquisition of transportation and installations services for WTGs, namely full turnkey and semi turnkey solutions. Third party

¹⁴⁸ Stena Renewable (2009)

¹⁴⁹ Total Wind (wwwa); Total Wind (wwwb)

¹⁵⁰ Egard, conversation (2011a); Bjarnegård, telephone interview (2011)

¹⁵¹ Cederberg, personal interview (2011)

¹⁵² Nilsson, supervisor meeting (2011)

¹⁵³ van Weele (2005)

logistics (3PL) services have similarities with semi turnkey solutions, especially concerning the contractors and the buyer responsibility. Fourth party logistics (4PL) services are more comparable to the full turnkey solutions, where a single contractor acquires all premises and where the buyer is relieved from responsibilities.

3PL services

The wind energy industry's dependence on multi-modal transportation has given rise to turnkey logistics projects managed by 3PL companies. These wind energy 3PL specialists arrange the entire movement of wind turbine components from various manufacturers to the wind farm, and their services also may include assembly and installation.¹⁵⁴

From the evolution out of transport containers, 3PL companies have developed competitive advantage potential by becoming responsible for packaging and damage control of shipments. Logistics groups are also sometimes responsible for arranging the loading and unloading of the components throughout all stages of transport, from ship to truck, as well as onsite assembly of the WTGs.¹⁵⁵

Transportation in the wind energy industry already clarifies the necessity of collaboration through the newly forming supply chain. At the initial loading of outbound products the transportation company, manufacturer, and the manufacturer's insurance company are all present. Typically, the logistics company, manufacturer, utility company, and operations and maintenance staff all take part in the assembly and installation of the wind turbines on the project site. The involvement of multiple supply chain in these processes illuminates the integral role that collaboration and information sharing play in maintaining a functioning supply chain as well as potentially optimizing the supply chain.¹⁵⁶

4PL services

4PL develops tailored solutions to meet the unique and special needs of each customer. 4PL emerges and acts as an electronic intermediate that connects suppliers, producers, carriers and customers to dynamic supply chain network. They provide integrated services for the operation of supply chains and manage the information and material flow between all parties involved. 4PL service providers contribute to the sustainable competitiveness of all the collaborating manufacturing and service companies.¹⁵⁷

The core idea of 4PL is to integrate the supply chain resources, which consists of the process of logistics order reception, logistics tasks decomposition, logistics

¹⁵⁴ Ozment & Tremwel (2007)

¹⁵⁵ Ibid.

¹⁵⁶ Ibid.

¹⁵⁷ Li, Ying, Liu, Chen & Huang (2003)

service chain modeling, logistics services mapping, logistics services chain construction, logistics services chain execution and KPI evaluation¹⁵⁸. Customers receive personalized, diversified integration solutions, and fast, high-quality and low-cost logistics services will be provided¹⁵⁹.

4.4 Identified key factors

There are several key factors that need to be taken into consideration when transporting, lifting, installing and coordinating a WTG. All the factors presented below have been identified during interviews with stakeholders within the wind power industry such as wind power companies, wind power manufactures, and subcontractors of transportation and installation services. Using several stakeholders has helped to cover different aspects that are important to consider when choosing appropriate suppliers. The factors presented below, are the most recurrent from the interviews.

Interfaces

Every interface regarding unloading, reloading and offloading of components constitutes a risk of damaging the wind turbine components. This risk is especially high if several subcontractors are used.¹⁶⁰

Delays and standstill can occur several times during transport from factory until the WTG is actually installed. Depending on how many subcontractors the purchasing company decides to use the risk varies in impact on costs. If one subcontractor is used for transportation of the WTGs and another for the installation services, the purchasing company might be responsible for any possible delays. Hence, the purchasing company has to pay the subcontractor of the installation services for the standstill that occurs.¹⁶¹ Depending on what crane the subcontractor uses the weekly hire range from approximately 160 KSEK to 560 KSEK excluding mobilization costs¹⁶². However, Rohwer (2011) means that “the risk of delays affecting the revenue stream in terms of produced and sold energy can never be eliminated”¹⁶³.

Risk for delays and standstill (unavoidable)

Eirefelt (2011) states that “delays and standstill can also be caused by unavoidable reasons, where the ultimate risk when lifting and installing the WTG is the wind”¹⁶⁴. The cranes used to lift the wind turbine components typically have a

¹⁵⁸ Qifeng (2010)

¹⁵⁹ Yao & Liu (2007)

¹⁶⁰ Rohwer, personal interview (2011); Bjarnegård, personal interview (2011)

¹⁶¹ Egard, personal interview (2011b); Bengtsson personal interview (2011)

¹⁶² Vindforsk, Energimyndigheten & Elforsk (2010)

¹⁶³ Rohwer, personal interview (2011)

¹⁶⁴ Eirefelt, email interview (2011)

wind restriction between 5 and 8 m/s¹⁶⁵. The crane driver is the one responsible for judging if a lift can be performed due to wind or not¹⁶⁶.

Both Setälä (2011) and Lundsgård (2011) argue that other weather conditions, such as ice and snow, are also risk factors that need to be taken into consideration already during the planning phase of a wind power project. However, it is hard to predict weather conditions in advance.¹⁶⁷

Safety

“The supplier must follow the established legislations and develop own systems for PDCA-cycles (Plan Do Check Act). Useful standards are OHSAS 18001 and ISO 14001, which control the suppliers own work environment and the external environment. By requesting for *Suppliers pre-qualification questionnaire* the purchasing company has the ability to evaluate the suppliers before a contract is signed and the actual project start” Olsson (2011) states during a conversation.¹⁶⁸

Safety on the project site is also of great essence. In order to secure the safety, an HSSE-plan (Health Safety Security Environment) is established¹⁶⁹. The HSSE-plan includes for example safety instructions, reports and responsibilities, policies regarding the environment, issues regarding health and hazard identifications¹⁷⁰.

Safety may also include the subcontractor’s own image of the subject. It is relevant to determine whether a subcontractor uses any guidelines developed by themselves and test whether the subcontractors approach to safety is comparable with the purchasing company’s.¹⁷¹

Resources

According to Egard (2011) “the more responsibility for procuring transportation and installation services the purchasing company takes on, the more resources are necessary staff wise from their behalf. More time will be spent on procurement, logistical planning, coordination and overseeing on site.” Therefore, it is an important factor to consider when choosing sources of supply.¹⁷²

¹⁶⁵ Vindforsk, Energimyndigheten & Elforsk (2010)

¹⁶⁶ Bengtsson, personal interview (2011)

¹⁶⁷ Setälä, email interview (2011); Lundsgård, personal interview (2011b)

¹⁶⁸ Olsson, conversation (2011)

¹⁶⁹ Rohwer, personal interview (2011); Thor, email interview (2011); Setälä, email interview (2011)

¹⁷⁰ Engineering Group for Contracting (www)

¹⁷¹ Lingard, Cooke & Blismas (2010)

¹⁷² Egard, personal interview (2011b)

Experience

“The manufacturing companies have a great advantage due to the fact that they have been coordinating these types of services for a long time, have dedicated personnel for the task and long-term relationships with subcontractors”, Bengtsson (2011) says in an interview¹⁷³. The complexity of these services requires specially trained personnel, rotation of crews due to tiredness because of the fast pace and proactive logistics planning¹⁷⁴.

It is important to work with experienced suppliers. For example, road surveys need to be performed along with the transportation subcontractor, especially in curves since the blades arrive in one piece and can be around 50 meters long¹⁷⁵. It is also important to assure that the actual site locations are suitable for cranes and transport equipment¹⁷⁶.

Cost

Rohwer (2011) clearly states that “the cost of transportation and installation services of course always accrues the purchasing company in the end. Although, the final price will vary depending on the supplier combination chosen. If the manufacturing company or a 4PL is responsible for realizing the services of transportation, lift and installation an additional marginal emerge, which partly consist of a percentage for the extra risk taken. An additional overhead cost for wind days is also added to the price from the manufacturing company. This marginal disappears if the purchasing company coordinates transportation and installation services themselves.”¹⁷⁷ However, according to Bengtsson (2011), “the same economies of scale as the manufacturing company has can be difficult to achieve, since their volumes are bigger”¹⁷⁸.

Control and responsibility distribution

The control situation for a wind power project differs depending on who is responsible for coordinating the construction. This concerns control over both the HSSE-plan and the contact with subcontractors throughout the project. Rohwer (2011) means that “if the WTG is bought turnkey, or coordinated by a 4PL, the buying company is not responsible for performing neither the HSSE review nor the contact with subcontractors. Depending on how the purchasing company perceives it, this can be viewed as an advantage or disadvantage.”¹⁷⁹

¹⁷³ Bengtsson, personal interview (2011)

¹⁷⁴ Väänänen, email interview (2011a); Segeren, email interview (2011); Setälä, email interview (2011)

¹⁷⁵ Lundsgård, personal interview (2011b)

¹⁷⁶ Väänänen, email interview (2011a); Segeren, email interview (2011); Setälä, email interview (2011)

¹⁷⁷ Rohwer, personal interview (2011)

¹⁷⁸ Bengtsson, personal interview (2011)

¹⁷⁹ Rohwer, personal interview (2011)

The question regarding responsibility is complicated and dependent of the number of subcontractors involved. The more subcontractors involved, the more obscurity regarding who is responsible for what.¹⁸⁰ Using international delivery terms, i.e. incoterms, facilitates the responsibility distribution between the different parties involved¹⁸¹.

Brand

According to Jensen (2011) “brand is something that is important to consider when choosing among several suppliers, since the company’s reputation and brand is something that is hard to gain but easy to lose if something were to happen¹⁸².” The following definition captures the essence of a brand: a name with power to influence buyers. A name becomes a brand by the saliency, differentiability, intensity and trust attached to the associations attached to it.¹⁸³ Values and image are the most important dimensions when evaluating the supplier’s service qualities. These might affect the customer brand in a negative way and need to be considered when choosing appropriate supplier.¹⁸⁴

4.5 Key factors from existing evaluation models

In order to secure that the most important key factors are covered regarding transportation and installation services of WTGs, information has also been gathered from existing evaluation models. The existing evaluation models used to find complementing evaluation criteria discuss supplier selection and evaluation. Since the models take the background of this study into consideration, the authors found them to be relevant. Table 1 present the criteria in its entirety.

Choi & Hartley (1996) and Muralidharan et al (2002) both use *flexibility* as an evaluation criterion in their studies. *Relationship* is something that is recognized by Cusumanu & Takeishi (1991) and Choi & Hartley (1996). Almost all of the authors in the summary of supplier selection criteria in Table 1 (Dickson (1966), Cusumanu & Takeishi (1991), Weber & Current (1993), Chaudhry et al (1993), Jayaraman et al (1999), Lee et al (2001), Muralidharan et al (2001), Prahinski & Benton (2004), Kreng & Wang (2005), Pi & Low (2005), Chang et al (2007) and Kuo et al (2010)) pinpoint *quality* as an important factor to consider. Kuo et al (2010) acknowledge *Corporate social responsibility (CSR)*, which is something that ISO 26000 also recognizes. These criteria are considered to be the most relevant for this study and are described further below.

¹⁸⁰ Thor, email interview (2011); Dahlin, email interview (2011)

¹⁸¹ van Weele (2005)

¹⁸² Jensen, email interview (2011)

¹⁸³ Kapferer (2008)

¹⁸⁴ Jabnoun & Khalifa (2005)

There are additional evaluation criteria in the summary in Table 1 that are taken into consideration by integrating them into the generated key factors. This can be exemplified by the fact that lead time; delivery time; delivery performance; delivery reliability; ability to respond to changed needs; and timeliness of delivery is processed within flexibility.

Flexibility

Flexibility refers to supplier's capability to support a change in the production plan of the enterprise¹⁸⁵. The flexibility may be affected by external factors, and it is important to measure the supplier's ability to reschedule deliveries. Also, the supplier's lead time is something to consider. The lead time can be evaluated when measuring the flexibility of the potential suppliers. From a customer perspective the shorter the lead time, the better.¹⁸⁶

Relationship

Supplier relationships are critical to any organization, since the suppliers have direct impact on the financial performance and profitability of a buying enterprise. The suppliers influence product development costs, inventory levels, manufacturing schedules and the timeliness of delivery of goods and services.¹⁸⁷

All successful companies build strong relationships with their suppliers, since they recognize the need to build bridges between their organization and the vendors that they work with by establishing strong buyer/seller relationships.¹⁸⁸

The relationship between a supplier and buyer can however be a complex one. Each party wants to maximize its time, resources, and cash investment, which might be competing priorities that can strain the relationship.¹⁸⁹

Quality

Service quality in a service encounter is recognized as being dependent upon the interactive process between the service provider and the service receiver¹⁹⁰. It is essential to evaluate the service quality of the potential suppliers, as it may differ between suppliers and countries. The measures should be relatable to the country and culture where the service is offered to secure the overall quality.¹⁹¹ However, the measurement of quality in services can be difficult, since, as earlier stated, services are intangible, heterogeneous, and a part of a simultaneous process¹⁹².

¹⁸⁵ Hsu, Chang & Hung (2007)

¹⁸⁶ Gong & Chen (2007)

¹⁸⁷ Middle East business & finance (www)

¹⁸⁸ Epiq (www)

¹⁸⁹ Manufacturing & Logistics IT (www)

¹⁹⁰ Svensson (2004)

¹⁹¹ Jabnoun & Khalifa (2005)

¹⁹² Svensson (2004)

When evaluating the different suppliers, quality measurement methods such as Quality Control Plans and Inspection and Test Plans (ITPs) might be useful. These methods help to ensure and verify whether work has been undertaken to the required standard and requirements, and that records are kept.¹⁹³ An ISO 9000 certification also helps to control the quality, given that it represents an international consensus on good quality management practices¹⁹⁴.

CSR

CSR is a concept where business organizations consider the interest of society by taking responsibility for the impact of their activities on customers, suppliers, employees, shareholders, communities and other stakeholders as well as their environment¹⁹⁵. This obligation shows that the organizations have to comply with legislation and voluntarily take initiatives to improve the well-being of their employees and their families as well as for the local community and society at large. Hence, CSR refers to strategies that corporations or firms use in order to conduct their business in a way that is ethical and society friendly. It can involve a variety of activities such as working in partnership with local communities, socially sensitive investment, developing relationships with employees, customers and their families, and involving in activities for environmental conversation and sustainability.¹⁹⁶

The CSR reporting also focus on a company's performance on factors as pollution, health and safety, human rights, child labor and other social and environmental issues. In most cases CSR reporting is voluntary, with companies including information in their annual reports or issuing separate CSR reports to address the issues. The primary reason for doing this is to provide investors with the information they desire to make decisions.¹⁹⁷

CSR aspects are rapidly emerging as a substantial issue for business and management. Legal and public pressures on the achievement of good environmental practice are increasing. These reasons cause business and public sectors to include CSR into its consideration framework. Examples of aspects measured within the area are environmental competency, environmental policies and pollution reduction activity.¹⁹⁸

¹⁹³ Quality Management Systems Guidelines (www)

¹⁹⁴ Koch (2008)

¹⁹⁵ International Organization for Standardization (www)

¹⁹⁶ Ismail (2009)

¹⁹⁷ Tschopp (2005)

¹⁹⁸ Thanaraksakul & Phruksaphanrat (2009)

5. Creating an initial evaluation model

In this chapter, the initial model for evaluating sourcing alternatives of wind turbine generator transportation and installation services is created. Firstly, a matrix illustrating the potential sourcing combinations within the wind power industry is presented. Then the key factors recognized in the previous chapter are divided between supplier and project specific criteria. Thereafter, the two steps in the evaluation model, Sourcing alternatives of wind power services (SAWPS), are described and exemplified.

5.1 Potential sourcing combinations within the wind power industry

The necessary activities, relevant to the wind power industry, recognized in the previous chapter, can also be referred to as the logistics services provided by suppliers. As earlier stated, logistics services mainly involve business-to-business relationships. To illustrate which of the necessary activities that are performed by who in different sourcing alternatives, Figure 12 below was created by the authors.

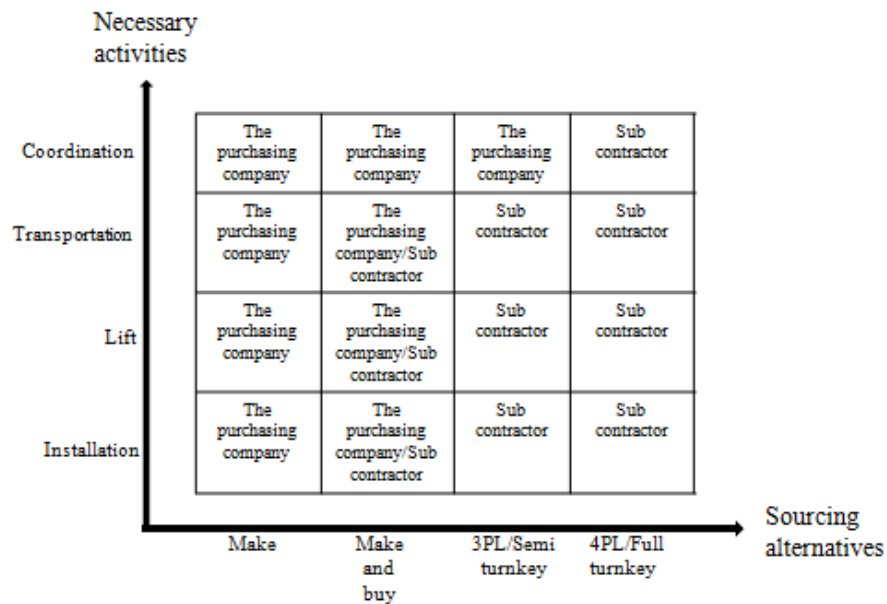


Figure 12. Potential sourcing combinations

The sourcing alternatives can also be related to the theory regarding single and multiple sourcing. Make and buy and 4PL/Full turnkey are both examples of situations where single sourcing is used, since only one supplier among many is used. 3PL/Semi turnkey can be referred to as either single or multiple sourcing, depending on the number of suppliers involved.

The recognized potential sourcing combinations will furthermore be used as the different sourcing categories in the evaluation model. In Table 2 below, the sourcing categories used in the model are connected to the sourcing alternative they belong.

Table 2. Connections between sourcing category and sourcing alternative

Sourcing category	Sourcing alternative
Make yourself	Make
Transportation	Make and buy or 3PL/Semi turnkey
Lift and installation	Make and buy or 3PL/Semi turnkey
Transportation, lift and installation	3PL/Semi turnkey
Full turnkey	4PL/Full turnkey

The reason why “transportation” and “lift and installation” are referring to both make and buy and 3PL/Semi turnkey is because these services can be sourced from two different suppliers but still be combined. Then, just as in “transportation, lift and installation”, the purchasing company only handle the coordination.

5.2 Dividing key factors into supplier and project specific criteria

The key factors presented in the previous chapter are more or less affectable by different actors in the logistics flow. This led to a separation between supplier and project specific criteria. The supplier specific criteria are directly connected to the suppliers’ performance and are easier to affect. The criteria that are project specific are associated with the procurement situation and the sourcing combination chosen. This separation will foremost facilitate the usage of the evaluation model. The key factors, divided into supplier and project specific, are presented in Table 3 below.

Table 3. Supplier and project specific criteria

Supplier specific	Project specific
Experience	Control and responsibility distribution
Safety	Interfaces
Quality	Risk for delays and standstill (unavoidable)
CSR	Resources
Brand	
Flexibility	
Relationship	

Cost is not included as one of the evaluation criteria, but is viewed upon lastly in both evaluation steps.

5.3 Sourcing alternatives of wind power services (SAWPS) – the specifics

The separation between supplier and project specific criteria facilitates, as previously stated, the evaluation and the relative weighting. The idea is to create an evaluation model, inspired by the theory regarding MCDA and SSMS, that is clear to follow and easy to use, where the output of the model is project specific. The created evaluation model takes all four multiple criteria problematiques into consideration. When rating the different suppliers and sourcing alternatives, it is of essence to first quantify the different key factors as far as possible, in order to secure the given score's accuracy.

The rating scale compiled for the evaluation model is divided into ten steps, in order to make the assessments of the various suppliers/sourcing alternatives as accurate as possible. Two endpoints are elucidated (0 and 10), with four steps in between (2, 4, 6 and 8). The significance of the odd numbers (1, 3, 5, 7 and 9), which are not presented in Figure 13 below, is that they convey the statement “either more or less”. The higher score an evaluation criteria receives, the better.

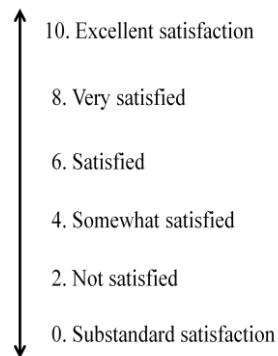


Figure 13. Rating scale

To facilitate for the user, guidelines for how to use the evaluation model *Sourcing alternatives of wind power services* (SAWPS) are presented below.

Step 1:

1. Perform a market survey in order to find appropriate suppliers and place them within the correct sourcing category.
2. Weight the supplier specific criteria and rate the suppliers within each sourcing category.
3. After taking cost into consideration, find best practices within each sourcing category.

Step 2:

4. Calculate percentage of total score for each best practice and rate them according to project specific criteria.
5. After taking cost into consideration, the most feasible solution for the specific project is found.

Below, the two steps are explained more carefully.

5.3.1 Step 1. Evaluating the supplier specific criteria

The supplier specific key factors need to be evaluated at a supplier basis to give accurate results. These can however be difficult to assess, since the suppliers often highlight their strengths more clearly than they bare their weaknesses. To reduce this risk, past experience with a certain supplier should be considered when scoring the suppliers. It is also necessary to consider that the evaluation model does not eliminate the subjectivity of the information gathered, it rather seeks to make the need for subjective judgements explicit and the process by which they are taken into account transparent. By quantifying the key factors as much as possible, the result is less likely to permeate subjectivity and is more easily comparable between the different options.

Firstly, a market survey is performed and appropriate suppliers for this type of services are found. The suppliers are categorized below the different sourcing categories; *make yourself*; *transportation*; *lift and installation*; *transportation, lift and installation*; and *full turnkey*.

The purchasing company then weights the supplier specific criteria between each other based on relevance and importance by the purchasing company. Hence, these are individual and unique for each purchasing company. The weighting between the supplier specific key factors has a total of 100. It reflects the criteria's relative importance and is used as a multiplying factor.

Thereafter, all suppliers are rated by the supplier specific criteria which are presented below, with on hand questions that are important to consider when scoring different supplier alternatives. The rating is performed according to the rating scale in Figure 13. Note that these criteria are supplier specific (based on supplier performance) and do not, apart from the cost, reflect the specific project.

A – Experience

- *Does the supplier have any knowledge from past experience?*
- *Are the supplier's personnel skilled and dedicated to the task?*

B – Safety

- *Is the supplier familiar with the purchasing company's HSSE-plan?*

- *Are the supplier's own guidelines corresponding with the purchasing company's?*

C – Quality

- *How satisfying is the service quality that the supplier provides?*
- *Are there differences in cultural aspects that need to be considered?*

D – CSR

- *Is CSR observed from the supplier's side?*
- *In which ways does the CSR work take shape in the supplier's organization?*

E – Brand

- *Are the supplier's values similar to the purchasing company's?*

F – Flexibility

- *Is the supplier capable to reschedule deliveries on short notice?*
- *How long is the supplier's lead time, i.e. from order to effect?*

G – Relationship

- *Are there any existing relationships to build on, both regarding suppliers and employees?*

Since there are several potential suppliers on the market, there is a need to screen these before an invitation to tender is sent out. The screening, performed by using the evaluation criteria above, helps to reduce time and resources spent from the purchasing company's side, since the invitation to tender only is sent out to a few potential suppliers within each sourcing alternative that got the highest score in the first evaluation step. If there are several suppliers within a sourcing category that receives equivalent scores, an invitation to tender can be sent out to more than one supplier. It is up to the purchasing company to decide how many invitation to tender they want to send out. When the purchasing company receives a tender from the supplier, with a suggested price and terms, the total cost can be evaluated (*What is the supplier's offer?, What is the content of the supplier's tender?*). Of course there can be more than one best practice within each category, but since the second step focus on project specific criteria it will not affect the relationship between two suppliers in the same sourcing category substantially.

Table 4 illustrates a simplified example of the procedure, where only three of the seven evaluation criteria are represented. As seen, there are two suppliers performing the services within procurement situation transportation, lift and installation. When using the model in a sharp project, there can be an unlimited number of suppliers within each sourcing category.

Table 4. Example of the supplier specific evaluating procedure (Step 1)

		Make yourself	Transportation	Lift and installation	Transportation, lift and installation		Full turnkey
Key factors	Weighting	The purchasing company	Supplier V	Supplier X	Supplier Y	Supplier Z	For example, the manufacturing company
A	30	$30 * 0 = 0$	$30 * 5 = 150$	$30 * 4 = 120$	$30 * 2 = 60$	$30 * 8 = 240$	$30 * 10 = 300$
B	45	$45 * 8 = 360$	$45 * 4 = 180$	$45 * 8 = 360$	$45 * 6 = 270$	$45 * 6 = 270$	$45 * 8 = 360$
C	25	$25 * 3 = 75$	$25 * 7 = 175$	$25 * 3 = 75$	$25 * 8 = 200$	$25 * 7 = 175$	$25 * 7 = 175$
Total score		435	505	555	530	685	835

After evaluating chosen suppliers by cost, a best practice within each sourcing category is selected and moves on to the second step of the evaluation model. Note that the make yourself alternative automatically will proceed to the second step, since the purchasing company is a lone actor within the category. The best practices within transportation and lift and installation can either be combined to a package solution or work as a complement when the purchasing company decides to make one service themselves. When combining two separate suppliers, these must work closely to ensure the safe transit of wind turbine components. CTM is an efficient tool of how well people work together both internally and with collaboration partners. This tool is important to take into consideration when using two different suppliers performing transportation and lift and installation.

5.3.2 Step 2. Evaluating the project specific criteria

It is also of great importance to take the project situation into account. Consequently, the second step of the evaluation model consists of a comparison between the best practices (on a supplier level), to find the most feasible project specific solution. For some purchasing companies all options might not be relevant, mainly due to lack of knowledge and consequently not a core competence. Therefore, to ensure the credibility of the evaluation model, a percentage from the first evaluation step will be calculated, i.e. a relation between best practices is accounted for. The percentage is then used as a weighting of the total score to find a final winner. The scores of the chosen best practices are added together and translated into a percentage for each best practice.

From the example in Table 4, the total score of all the best practices is 3 015 (435+505+555+685+835). The outcome is presented in Table 5.

Table 5. Percentage of total score for each sourcing category

Sourcing category	Score	Percentage of total score
Make yourself – the purchasing company	435	(435/3 015) 14%
Transportation – Supplier V	505	(505/3 015) 17%
Lift and installation – Supplier X	555	(555/3 015) 18%
Transportation, lift and installation – Supplier Z	685	(685/3 015) 23%
Full turnkey – the manufacturing company	835	(835/3 015) 28%

The project specific key factors are presented below, including questions to consider when scoring the different best practices.

H – Control and responsibility distribution

- *How many different suppliers are used?*
- *Is there one supplier/coordinator responsible for the whole process?*
- *Are there any guidelines referring to when the responsibility is transferred to the next supplier (if multiple are used)?*

I – Interfaces

- *How many interfaces, regarding onloading, reloading and offloading, are necessary for this project?*
- *How many different suppliers are used?*

J – Risk for delays and standstill (unavoidable)

- *Does the supplier have any back-up plans for how to deal with harsh weather conditions?*

K – Resources

- *Are there many resources that the purchasing company must add on site or concerning the overall coordination?*
- *Are the necessary resources available at the purchasing company?*

The percentage for each alternative is multiplied with the total score from Step 2. The main difference between the two steps is the rating. When evaluating the best practices in each sourcing alternative, the key factors are not internally weighted and are therefore equally important. Instead, the percentage of the score from Step 1 is regarded. The same rating scale as the one in Step 1 is used, see Figure 13. Table 6 illustrates a simplified version of the procedure with the preceding example, where only three of the actual four criteria are taken into consideration.

Table 6. Example of the project specific evaluation procedure (Step 2)

	Make yourself	Transportation	Lift and installation	Transportation, lift and installation	Full turnkey
Key factors	The purchasing company	Supplier V	Supplier X	Supplier Z	The manufacturing company
	0.14	0.17	0.18	0.23	0.28
H	10	8	8	6	4
I	10	4	4	8	10
J	8	3	3	6	7
Total score	0.14 * (10+10+8)= 3.9	0.17 * (8+4+3)= 2.5	0.18 * (8+4+3)= 2.7	0.23 * (6+8+6)= 4.6	0.28 * (4+10+7)= 5.9

When the total score is calculated, the “winning” alternative is estimated. It is also important to consider the cost (*What is the supplier’s offer?, What is the content of the supplier’s tender?*) in the second evaluation step, since this might affect the final decision. After performing the evaluation according to the project specific criteria, the cost of the alternatives that received the highest score is once again viewed upon. If the alternative that received the highest score also is the most expensive, in this example the full turnkey alternative, it might be of value to consider the next best alternative instead, here Supplier Z.

6. Adjusting the model and presenting the final version

In this chapter, the SAWPS-model created in the preceding chapter is adjusted through interviews. After adapting the model to the interviewees' feedback, the final version of the SAWPS-model is presented.

6.1 Adjusting through interviews

The SAWPS-model is adjusted through interviews with people in the business world. Below, the methodology for testing and the conclusions drawn are presented.

6.1.1 Methodology for adjusting

Semi-structured interviews have been performed with the following eight people from different segments within the business world.

- Johan Andersson, Purchasing and logistics, Peab (telephone interview)
- Magnus Axelsson, Head of Construction, E.ON Vind Sverige AB (personal interview)
- Per Brännström, Project manager Construction, Grontmij AB (personal interview)
- Magnus Franck, Vice President Supply Chain Management, Vestas Northern Europe (telephone interview)
- Gunnar Fredriksson, Vice President, Svensk Vindenergi; Mattias Wondollek, Project Manager, Svensk Vindenergi (telephone conference)
- Christian Stenqvist, Ph. D. student Environmental and Energy Systems Studies, Lund University (personal interview)
- Olli Väänänen, Heavy cranes Manager, Pekkaniska Group (email conversation)

The interviewees were firstly contacted via telephone, to establish a connection. They were given a brief introduction to the subject, before a further description about the authors and the thesis was sent out via email. Chapter 5, Creating an initial evaluation model, was attached and posed as the base of the interview. Three personal interviews, two telephone interviews, one telephone conference, and one e-mail interview was performed, based around the following questions;

- What do you think about the criteria in the model?
 - o Are there any criteria that you want to highlight more?
 - o Are there any criteria that you consider as not relevant?
 - o Are there any criteria missing in the model?
- What do you think about the structure of the model?

- Is there anything unclear about it?
- Is there anything that you feel would be better to perform differently?

By interviewing people from a variety of fields, the model will see to important areas. It will also ensure the model's usability and affect its generalizability in a positive way. The outcome of the interviews is viewed as recognized potential improvement areas, where actions will be taken to revise the model before presenting the final version.

6.1.2 Conclusions from interviews

Below, the conclusions drawn from the interviews are presented along with the actions taken in order to improve the final version of the model. For more information see Appendix 1, where the interviewees' answers are separately taken into consideration and compiled in a table.

Several of the interviewees pointed out the lack of criterion regarding the supplier's financial status. This is an important factor to consider since the chosen supplier must be able to bare the financial risk if something were to happen to the wind turbine components during transportation, lift or installation. It is of essence that the financial status of the supplier is reviewed before entering into an agreement. The action for taking this input into consideration is to add a criterion regarding the financial status of the supplier, with supplementary questions that are important to review. This assessment is performed before placing the suppliers in the correct sourcing category.

Some of the improvements recognized by the interviewees led to an update of the questions used when rating the suppliers. Firstly, references to previous projects are observed in the ranking in order to reduce the element of subjectivity. It is also important to make sure that the image of a certain supplier does not impact the rating too much. The suppliers' equipment and employees is significant to review, as well as their approach to environmental issues. More general comments regarding making the key factors more explicit, lead to an overall update of the questions within the evaluation criteria.

Clarifications and information is added to make the SAWPS-model more understandable. To simulate worst/best/normal case situations is a useful approach when there are uncertainties regarding the rating, hence information concerning this is added. A clarification regarding market survey is made, which from now is entitled scan the market, and the procedure for performing this is also added. Hence, a shortlist is created. An interviewee pointed out that the subjectivity values that affect the outcome and the difference between supplier and project specific criteria should be clearer. Information relating to these comments is added. A flow chart is also added in order to simplify the usage and make the different steps more clear to follow.

Some comments are not taken into consideration when adjusting the model. One interviewee suggested that the project specific criteria should be weighted, as in the first step. Thus, the authors believe these criteria to be of equal importance. The differences between the sourcing categories will instead show in the actual rating. Two comments received will be viewed as potential improvement areas, which can be added once the model has been tested and evaluated. The first comment was regarding applying a factor on the sourcing categories in the second step, in order to take the company's ability to act in certain categories into consideration. For example, if it is not possible for a company to make transportation, lift and installation themselves this category would have a low factor. The second comment was to determine the procurement competencies within the purchasing company to ensure a fair weighting and rating. The authors found this to be challenging to put in the model, since it is up to the purchasing company to secure the competency of their employees. As an interviewee expressed it "the SAWPS-model is a strong tool in combination with the right procurement competences, but a dangerous tool when a blind organization uses it¹⁹⁹".

6.2 Final version of the SAWPS-model

Below, the final version of the SAWPS-model is presented. The potential improvement areas and actions that were recognized in chapter 6.1.2/Appendix 1 have been taken into consideration when finalizing the evaluation model.

6.2.1 Dividing key factors into supplier and project specific criteria

The key factors recognized are more or less affectable by different actors in the logistics flow. Some criteria are based on the supplier's specific characteristics and practices, and these might vary greatly within each sourcing combination. Other criteria are based more on the sourcing combination that the supplier belongs to, and the individual supplier affects the scoring to a lesser extent. To distinguish these criteria a separation between the supplier and project specific criteria was made.

The supplier specific criteria are directly connected to the suppliers' performance and are easier to affect. These criteria can be scored before a current project is studied, as they are not affected by the characteristics of the specific project. The criteria that are project specific are associated with the procurement situation and these are connected to a specific project. These criteria are difficult to score before an invitation to tender is sent out and vary between different projects in, for example, the resources that are needed.

¹⁹⁹ Andersson, telephone interview (2011)

This separation will foremost facilitate the usage of the evaluation model. The key factors, divided into supplier and project specific, are presented in Table 7 below.

Table 7. Supplier and project specific criteria

Supplier specific	Project specific
Experience	Control and responsibility distribution
Safety	Interfaces
Quality	Risk for delays and standstill (unavoidable)
CSR	Resources
Brand	
Flexibility	
Relationship	

Financial status and cost

Financial status and cost are two factors that will be considered in the evaluation model, although not included as supplier or project specific criteria. In order for the purchasing company to enter into an agreement with a supplier, a stable financial situation is a necessity. Therefore, the supplier’s financial situation is reviewed before entering the evaluation model. Costs are viewed upon lastly in both the first and second step of the evaluation model.

6.2.2 Sourcing alternatives of wind power services (SAWPS) – the specifics

When rating the different suppliers and sourcing alternatives, it is of essence to first quantify the different key factors as far as possible, in order to secure the given score’s accuracy.

The rating scale compiled for the SAWPS-model is divided into ten steps, in order to make the assessments of the various suppliers/sourcing alternatives as accurate as possible. Two endpoints are elucidated (0 and 10), with four steps in between (2, 4, 6 and 8). The significance of the odd numbers (1, 3, 5, 7 and 9), which are not presented in Figure 14 below, is that they convey the statement “either more or less”. The higher score an evaluation criteria receives, the better.

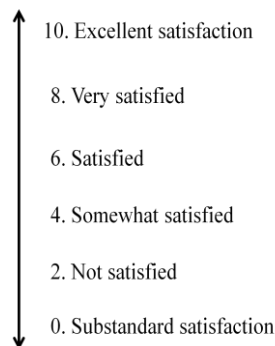


Figure 14. Rating scale

Sometimes it can be difficult to rate the suppliers when there are uncertainties in the market or when the perception of a specific supplier is indefinite. To reduce the uncertainties worst/best/normal case situations can be created, where the normal case is the present rating situation. When evaluating a worst case situation the suppliers receive the lowest possible rating imagined by the purchasing company. In the best case situation, the supplier receives the highest possible rating. These two extremes show the uncertainties of using a specific supplier in the current situation, and the information can be relevant when choosing an appropriate supplier for a certain project.

A flow chart for how to use the evaluation model *Sourcing alternatives of wind power services* (SAWPS) is presented in Figure 15 below.

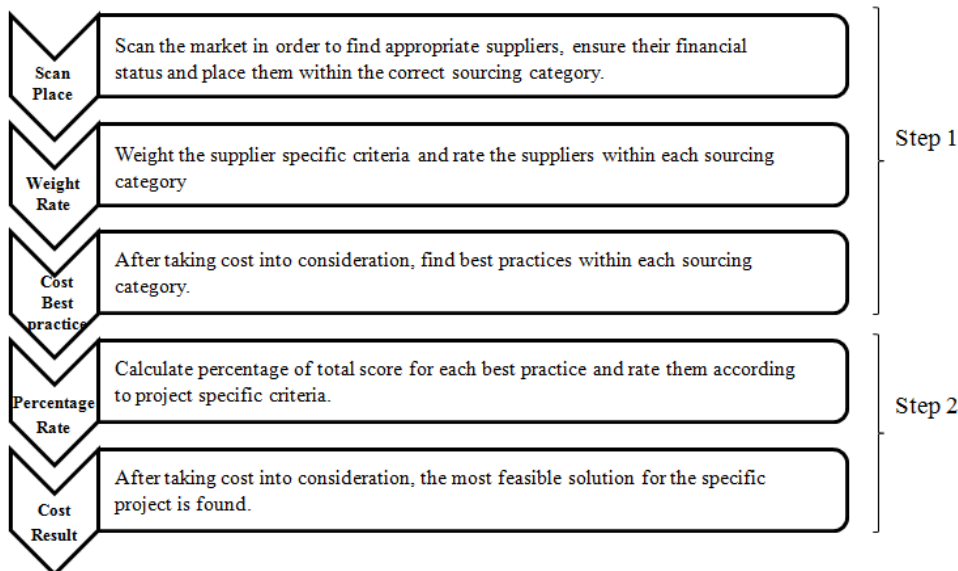


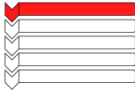
Figure 15. Flow chart of the evaluation process

Below, the two steps are explained more carefully.

6.2.2.1 Step 1. Evaluating the supplier specific criteria

The supplier specific key factors need to be evaluated at supplier basis to give accurate results. These can however be difficult to assess, since the suppliers often highlight their strengths more clearly than they bare their weaknesses. To reduce this risk, past experience with a certain supplier should be considered when scoring the suppliers. Contacting references is another way of securing accurate answers. It is also necessary to consider that the evaluation model does not eliminate the subjectivity of the information gathered, it rather seeks to make the need for subjective judgements explicit and the process by which they are taken into account transparent. By quantifying the key factors as much as possible, the

result is less likely to permeate subjectivity and is more easily comparable between the different options.

 Firstly, a shortlist is created by scanning the market and appropriate suppliers for this type of services are consequently found. When starting the process of scanning the market for suitable suppliers it is important for the purchasing company to be open-minded. Below, some guidelines are presented that might be helpful to use when scanning the market:


- Information regarding suppliers can be collected both through the Internet and through collaboration with other stakeholders in the industry.
- A geographical limitation may be appropriate to implement, in order to limit the number of potential suppliers.
- When first scanning the market, it is essential for the purchasing company to avoid criticism from past experiences. These experiences will be considered during the upcoming evaluation.

To ensure the supplier's financial status, it is important for the purchasing company to consider the following;

- *Does the supplier have any financial remarks?*
- *Are the supplier's financial statements satisfactory?*
- *Can the supplier handle to pay a possible penalty fee if something happens with the WTG?*
- *Can the supplier financially bare the risk for incidents and delays?*
- *What warranties can the supplier offer?*

If a supplier does not fulfill these requirements, it will not be evaluated.

The suppliers are categorized below the different sourcing categories; *make yourself; transportation; lift and installation; transportation, lift and installation; and full turnkey.*

 The purchasing company then weights the supplier specific criteria between each other based on relevance and importance by the purchasing company. Hence, these are individual and unique for each purchasing company. The weighting between the supplier specific key factors has a total of 100. It reflects the criteria's relative importance and is used as a multiplying factor.

Thereafter, all suppliers are rated by the supplier specific criteria which are presented below, with on hand questions that are important to consider when scoring different supplier alternatives. The rating is performed according to the rating scale in Figure 14. Note that these criteria are supplier specific (based on supplier performance) and do not reflect the specific project.

A – Experience

- *Does the supplier have any knowledge from past experience?*
- *What references does the supplier have from previous projects?*
- *What type of projects has the supplier previously worked with?*
- *What is the supplier's core competence?*
- *Are the supplier's personnel skilled and dedicated to the task?*
- *Does the supervisor have a satisfying CV?*

B – Safety

- *Is the supplier familiar with the purchasing company's HSSE-plan?*
- *What are the supplier's safety guidelines?*
- *Are the supplier's own guidelines corresponding with the purchasing company's?*
- *Does the supplier follow their guidelines (contact references)?*
- *Is the supplier certified according to OHSAS 18001 and ISO 14001?*
- *Does the supplier have a system for PDCA?*
- *Does the supplier risk identify their own work?*
- *Does the supplier follow existing legislation?*

C – Quality

- *How satisfying is the service quality that the supplier provides?*
- *Are there differences in cultural aspects that need to be considered?*
- *Is the supplier ISO 9000 certified?*
- *What type of machines/tools does the supplier use?*
- *Is the supplier using competent employees for the project?*
- *Does the supplier use any quality measurement methods for continuous improvements, such as Quality Control Plans or Inspection and Test Plans?*

D – CSR

- *Is CSR observed from the supplier's side?*
- *In which ways does the CSR work take shape in the supplier's organization?*
- *Are the supplier's means of transportation environmentally friendly compared to the standard in the business (way of driving, fuel and environmental classification)?*
- *Is the supplier supporting any aid organization?*

E – Brand

- *Are the supplier's values similar to the purchasing company's?*
- *Has the supplier been involved in any scandals in previous collaborations?*

F – Flexibility

- *Is the supplier capable to reschedule deliveries on short notice?*
- *How long is the supplier’s lead time, i.e. from order to effect?*
- *Does the supplier use any tools for route optimization?*
- *Is the supplier prepared to renounce conveniences to complete the project?*

G – Relationship

- *Are there any existing relationships to build on, both regarding suppliers and employees?*
- *How have previous collaborations with the supplier worked out?*



After evaluating chosen suppliers by cost (*What is the supplier’s offer?, What is the content of the supplier’s tender?*), a best practice within each sourcing category is selected and moves on to the second step of the evaluation model. Note that the make yourself

alternative automatically will proceed to the second step, since the purchasing company is a lone actor within the category. The best practices within transportation and lift and installation can either be combined to a package solution or work as a complement when the purchasing company decides to make one service themselves. When combining two separate suppliers, these must work closely to ensure the safe transit of wind turbine components. CTM is an efficient tool of how well people work together both internally and with collaboration partners. This tool is important to take into consideration when using two different suppliers performing transportation and lift and installation.

Table 8 below illustrates a simplified example of the procedure, where only three of the seven evaluation criteria are represented. These three criteria are weighted with a total amount of 100, where key factor A received 30 points, key factor B 45 points, and key factor C 25 points. The different suppliers are then scored from 0 to 10 depending on their characteristics and performance. The higher score they receive, the better. The rating of each key factor is then multiplied with the weighting of the key factors. Lastly, the scores are summarized within every supplier category and a total score for each supplier is obtained. As seen, there are two suppliers performing the services within procurement situation transportation, lift and installation. When using the model in a sharp project, there can be an unlimited number of suppliers within each sourcing category.

Table 8. Example of the supplier specific evaluating procedure (Step 1)

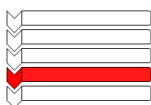
		Make yourself	Transportation	Lift and installation	Transportation, lift and installation		Full turnkey
Key factors	Weighting	The purchasing company	Supplier V	Supplier X	Supplier Y	Supplier Z	For example, the manufacturing company
A	30	$30 * 0 = 0$	$30 * 5 = 150$	$30 * 4 = 120$	$30 * 2 = 60$	$30 * 8 = 240$	$30 * 10 = 300$
B	45	$45 * 8 = 360$	$45 * 4 = 180$	$45 * 8 = 360$	$45 * 6 = 270$	$45 * 6 = 270$	$45 * 8 = 360$
C	25	$25 * 3 = 75$	$25 * 7 = 175$	$25 * 3 = 75$	$25 * 8 = 200$	$25 * 7 = 175$	$25 * 7 = 175$
Total score		435	505	555	530	685	835

Since there are several potential suppliers on the market, there is a need to screen these before an invitation to tender is sent out. The screening, performed by using the evaluation criteria above, helps to reduce time and resources spent from the purchasing company's side, since the invitation to tender only is sent out to a few potential suppliers within each sourcing alternative that got the highest score in the first evaluation step. If there are several suppliers within a sourcing category that receives equivalent scores, an invitation to tender can be sent out to more than one supplier. It is up to the purchasing company to decide how many invitation to tender they want to send out. When the purchasing company receives a tender from the supplier, with a suggested price and terms, the total cost can be evaluated (*What is the supplier's offer?, What is the content of the supplier's tender?*). Of course there can be more than one best practice within each category, but since the second step focus on project specific criteria it will not affect the relationship between two suppliers in the same sourcing category substantially.

In the example above, Supplier Y is rejected due to low score and a not so beneficial tender. The other suppliers are considered to be best practices within their sourcing category and move on to Step 2 in the SAWPS-model.

6.2.2.2 Step 2. Evaluating the project specific criteria

It is also of great importance to take the project situation into account. Consequently, the second step of the evaluation model consists of a comparison between the best practices (on a supplier level), to find the most feasible project specific solution.



For some purchasing companies all sourcing options might not be relevant, mainly due to lack of knowledge and consequently not a core competence. Therefore, to ensure the credibility of the evaluation model, a percentage from the first evaluation step will

be calculated, i.e. a relation between best practices is accounted for. The percentage is then used as a weighting of the total score to find a final winner. The scores of the chosen best practices are added together and translated into a percentage for each best practice. For the example in Table 8, the result would be the following:

The total score of all the best practices is 3 015 (435+505+555+685+835) which gives the following outcome, presented in Table 9 below.

Table 9. Percentage of total score for each sourcing category

Sourcing category	Score	Percentage of total score
Make yourself – the purchasing company	435	(435/3 015) 14%
Transportation – Supplier V	505	(505/3 015) 17%
Lift and installation – Supplier X	555	(555/3 015) 18%
Transportation, lift and installation – Supplier Z	685	(685/3 015) 23%
Full turnkey – the manufacturing company	835	(835/3 015) 28%

The project specific key factors are presented below, including questions to consider when scoring the different best practices.

H – Control and responsibility distribution

- *How many different suppliers are used?*
- *Is there one supplier/coordinator responsible for the whole process?*
- *Are there any guidelines referring to when the responsibility is transferred to the next supplier (if multiple are used)?*
- *If multiple suppliers are used – has everyone agreed with the guidelines referred to in the previous question?*
- *Are there incoterms regulating the control and responsibility distribution?*

I – Interfaces

- *How many interfaces, regarding onloading, reloading and offloading, are necessary for this project?*
- *How many different suppliers are used?*
- *What does the timeframe look like – are the suppliers flexible?*
- *How does the supplier handle possible delays – what costs reside?*

J – Risk for delays and standstill (unavoidable)

- *Does the supplier have any back-up plans for how to deal with unexpected occurrences such as harsh weather conditions, heavy traffic or accidents along the transportation route?*

K – Resources

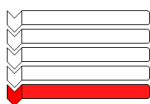
- Are there many resources that the purchasing company must add on site or concerning the overall coordination?
- Are the necessary resources available at the purchasing company?
- Is there any equipment that needs to be added on site?

The percentage for each alternative is multiplied with the total score from Step 2. The main difference between the two steps is the rating. When evaluating the best practices in each sourcing alternative, the key factors are not internally weighted and are therefore equally important. Instead, the percentage of the score from Step 1 is regarded. The same rating scale as the one in Step 1 is used, see Figure 14. When the total score is calculated, the “winning” alternative is estimated.

Table 10 below illustrates a simplified version of the procedure with the preceding example, where only three of the actual four criteria are taken into consideration. These criteria are rated from 0 to 10 for each supplier, depending mostly on the sourcing combination but also on their tender for the specific project. After summarizing the rating for each supplier, this is multiplied with the percentage of the total score in the first step of the evaluation (see Table 9). A total score for each supplier is obtained and a final winner can be elected.

Table 10. Example of the project specific evaluation procedure (Step 2)

	Make yourself	Transportation	Lift and installation	Transportation, lift and installation	Full turnkey
Key factors	The purchasing company	Supplier V	Supplier X	Supplier Z	The manufacturing company
	0.14	0.17	0.18	0.23	0.28
H	10	8	8	6	4
I	10	4	4	8	10
J	8	3	3	6	7
Total score	0.14 * (10+10+8)= 3.9	0.17 * (8+4+3)= 2.5	0.18 * (8+4+3)= 2.7	0.23 * (6+8+6)= 4.6	0.28 * (4+10+7)= 5.9



When the total score is calculated, the “winning” alternative is estimated. It is also important to consider the cost (*What is the supplier’s offer?, What is the content of the supplier’s tender?*) in the second evaluation step, since this might affect the final decision.

After performing the evaluation according to the project specific criteria, the cost of the alternatives that received the highest score is once again viewed upon. If the

A sourcing evaluation model for transportation and installation services of wind turbines

alternative that received the highest score also is the most expensive, in this example the full turnkey alternative, it might be of value to consider the next best alternative instead, here Supplier Z.

An important issue to consider throughout the evaluation model is the subjective factor that can affect the outcome. It is also essential to note that the differences in the outcome of the rating should be viewed as guidelines for making the final decision. Hence, the numbers should not be viewed as hard facts but rather as a supportive base.

7. Applying the SAWPS-model to E.ON Vind

This chapter focuses entirely on E.ON Vind and the Knäred project. Firstly, a brief introduction to E.ON Vind and more detailed description of Construction is given. Thereafter, some background information about the Knäred project is presented before adapting the SAWPS-model to E.ON Vind and applying it to Knäred. Conclusions regarding risks and possibilities are then compiled before reviewing possible implications on Construction's process map.

7.1 E.ON Vind

The E.ON group is one of the world's largest privately owned energy producing companies, mainly producing electricity, gas and heat. Within the group, there are about 50 subsidiary companies in Europe and America. E.ON's head quarter is in Dusseldorf, Germany, and the company has a turnover of around 600 billion SEK.²⁰⁰

E.ON Vind is, as earlier stated, a part of E.ON Climate and Renewables. As seen in Figure 16 below, there are four core processes with the common goal to produce and deliver energy in order to achieve customer satisfaction – Identify and secure business opportunities, Develop project, Construct site and Operate and maintain site.²⁰¹

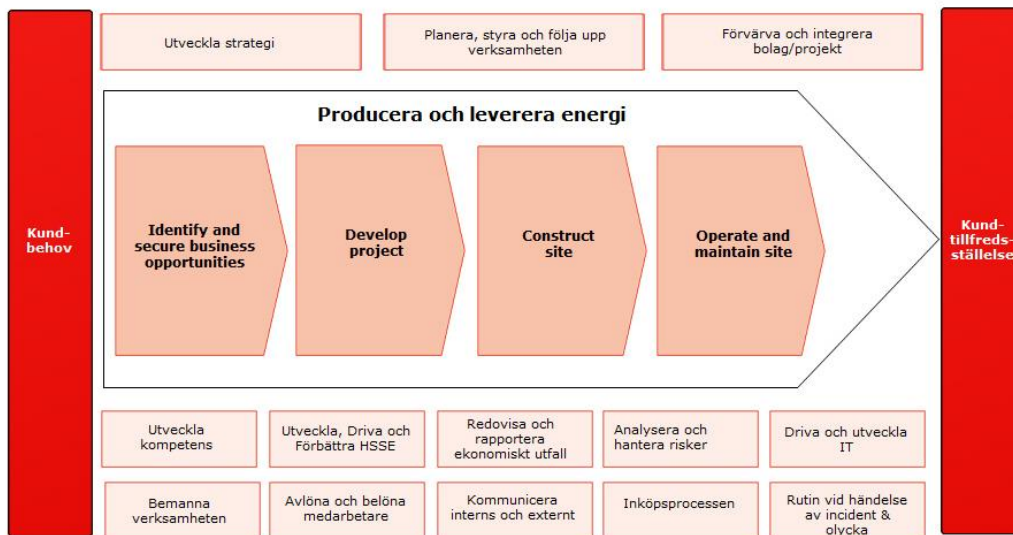


Figure 16. E.ON Vind Sverige AB

²⁰⁰ E.ON (www)

²⁰¹ Axelsson, confirmed information from intranet (2011)

In order to create an understanding of the flow between the core processes, a short introduction to each process is presented below.

Identify and secure business opportunities

A need of wind power is identified, consequently the search for business partners and site locations begin. Once a potential project is created it is evaluated and a project offer is made, where information is given to the land owners. Contracts with the land owners need to be established in order for the project to be planned more closely. After an investment calculation has been made, a decision about Gate 1 (G1) can be concluded. Hence, this first phase aims at deciding whether the project is attractive enough to start spending money externally, for example in pre-engineering activities. It ends in a G1 clearance, which gives the formal approval to continue with the project, including spending money externally. G1 is mainly focusing on the strategic fit of the investment project.²⁰²

Develop project

When a project is cleared at G1, it passes through to “Develop project”. Here, technical evaluations are performed, e.g. wind measurements and road planning, and introductory procurement processes with subcontractors are initiated. Parallel, authorizations such as environmental and building permits are applied for. The second phase ends in a formal investment decision, preceded by a Gate 2 (G2) clearance. In order to receive G2 clearance, information needs to be updated or added to the project template. Results from more detailed investigations during pre-studies must be included. Cost estimates must be based on binding contracts from suppliers and parameters such as energy prices and WACC must be updated.²⁰³

Construct site

Further information about Construction, and their work process, is found in 7.2 Construction.

Operate and maintain site

When the wind park is commissioned, it is handed over to Operations & Maintenance (O&M), who control the operation and service of the park. This department is, beyond being responsible for planning the operation, planning the maintenance and monitoring the park, liable for remedying any errors. To invoice delivered electricity and to compile, evaluate and optimize in order to streamline the production of electricity also falls under the field of responsibility of O&M.²⁰⁴

²⁰² Axelsson, confirmed information from intranet (2011)

²⁰³ Ibid.

²⁰⁴ Ibid.

Sign contracts and possibly end negotiate with suppliers

Contracts are signed and possible end negotiations with suppliers regarding grid, WTGs and civil work (roads and foundations) are held. The purpose of this activity is to connect suppliers with correct terms for all of E.ON Vind's stakeholders, both internal and external.²¹⁰

Prepare the construction start

In this sub process an introductory meeting, as well as a coordination meeting, is initially held. Thereafter, activities regarding permits, documentation and applications take place. The outputs of these activities all contribute to the fact that a job site can be established.²¹¹

Monitor and coordinate construction

There are five activities within this sub process that simultaneously take place in order for a WTG to become ready to operate. Summon a building meeting, coordinate contractors, monitor the construction job on site, perform an HSSE-round and follow up the control plan/control program are all activities necessary for the completion of a WTG.²¹²

This sub process and the two following are performed for every WTG, hence marked on the process map.

Commission and inspect the WTG

A final inspection of the WTG is performed before it is commissioned. The manufacturing company is responsible for the commissioning and the rectification of any errors. In this sub process, parts of the project are technically closed in SAP in order to allow depreciations of the turbines.²¹³

Document and hand over the WTG

The purpose of this sub process is to complete the documentation regarding the WTG, verify that it is working properly and subsequently to hand the WTG over to O&M²¹⁴.

Commission and inspect the facility

When all the WTGs are commissioned, a commissioning and inspection of the entire facility is performed. Errors are being detected and rectified.²¹⁵

²¹⁰ Axelsson, confirmed information from intranet (2011)

²¹¹ Ibid.

²¹² Ibid.

²¹³ Ibid.

²¹⁴ Ibid.

²¹⁵ Ibid.

Close and evaluate project

In the final sub process within Construction the project is closed and evaluated internally. A decision about closing the project is made, and thereafter the project is closed in SAP and evaluated. The suppliers are also evaluated for future use. A final report is assembled, and the final documentation is compiled, cleared and archived before the project can be considered as finalized.²¹⁶

7.3 The Knäred case

E.ON Vind is currently developing a wind power project in Knäred, Sweden, which is located in the county of Laholm. The project includes 10 Vestas V-90 turbines, each with a rated power effect of 2 MW and a maximum total height of 150 meters.²¹⁷

Area description

The area, which is divided into two compartments, is situated by Björkered approximately 3 kilometers northeast of Knäred. The landscape surrounding Knäred is essentially forestry area with open lots around the relatively sparsely populated area. The mount where the WTGs are suggested to be placed is around +125-140 meters above sea level. In the low points of the terrain, there are areas dominated by swamps which are connected to each other by smaller watercourses/-ditches. The gradient of the roads is estimated as not critical.²¹⁸

Natural environment

The suggested placement of the WTGs implies that half of them will be built on storm-felled areas, four of them in production forest and one in deciduous forest. The WTGs will be placed in a way in which they do not concern any swamps or other nature values. There are not any known ancient monuments that will be affected. Storage of material and assemblage of the rotor will, when possible, be executed within non-wooded areas.²¹⁹

Figure 18 below illustrates the placement of the WTGs, the surrounding area and the road placement.

²¹⁶ Axelsson, confirmed information from intranet (2011)

²¹⁷ Rasmussen, personal interview (2011)

²¹⁸ Ibid.

²¹⁹ Ibid.

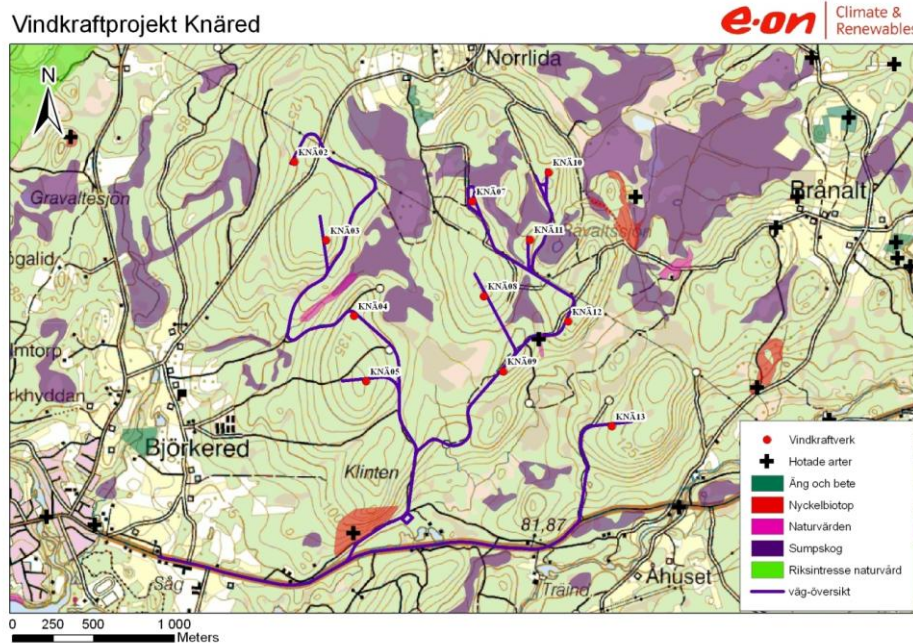


Figure 18. Surrounding area, Knäred²²⁰

Expected environmental impact

Broadening of existing roads and establishment surfaces locally implies that some trees need to be felled and the ground to be leveled. Both existing roads and the access roads that are to be built need to be strengthened.²²¹

Each WTG is placed on a foundation which is 20 meters in diameter. When lifting the WTGs, a surface of about 800 square meters need to be freed next to the foundation for the crane and the components.²²²

Time frame

The time frame for Construction's involvement in the Knäred project is estimated to a total of 1 year and 18 weeks. Lift and installation of the 10 WTGs take approximately 12-14 weeks and is projected to start February 13th 2012. Due to certain circumstances the time schedule is already constraint.²²³

Conclusions

By reviewing the description of the Knäred project as well as communicating with the project leader in the construction phase, Mats Egard, no unusual challenges regarding the natural environment are detected. There is a gradient on some of the

²²⁰ Rasmusson, material received after personal interview (2011)

²²¹ Rasmusson, personal interview (2011)

²²² Egard, conversation (2011a)

²²³ Egard, conversation (2011b)

roads, but this is most likely not critical for the execution of transporting the components to the project site. The exact gradient is however unknown, since the civil works on the project site (roads and foundations) is not yet initiated.²²⁴

The most critical factors are unfortunately unavoidable. Apart from wind restrictions that might occur, the risk of snow and ice is large due to the fact that transportation, lift and installation will be performed in January/February 2012. However, these factors cannot be predicted in advance which makes them impossible to eliminate. Augmented time frames and terms in the contract can minimize the possible additional costs.

7.4 Applying the SAWPS-model to Knäred

The SAWPS-model is applied to the Knäred project in order to find the most feasible solution regarding transportation and installation services, based on obtainable information. Note that certain terms are negotiable, and may be affected if competent personnel initiate negotiations with the suppliers.

The sourcing categories where E.ON Vind need to perform one or two parts themselves, make yourself and make and buy, are excluded from the evaluation model. Transporting wind turbine components is something that E.ON Vind most likely never will perform, since it requires the company to acquire their own means of transportation. For E.ON Vind to make lift and installation themselves and buy transportation from an outside supplier can be considered a possible solution, but not within the next 5 years or so. At this moment, the company's core competence lies within coordinating these activities, hence where focus should lie.²²⁵

Therefore, make yourself and make and buy are excluded from the SAWPS-model when applying it to E.ON Vind. This will affect Figure 19, regarding potential sourcing alternatives, as follows below.

²²⁴ Egard, conversation (2011b)

²²⁵ Axelsson, conversation (2011b)

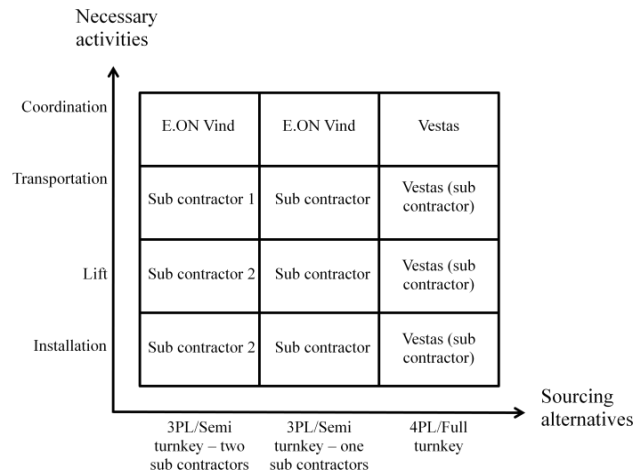


Figure 19. Potential sourcing alternatives, adjusted to E.ON Vind

E.ON Vind coordinate the transportation, lift and installation in the different 3PL alternatives, where either one or two subcontractors are used. If the WTG instead is bought turnkey from Vestas (which will be the turbine supplier in the Knäred project), they arrange these services. Important to note is that transportation, lift and installation is not a core competence of Vestas which is why they buy these services from outside suppliers, hence adding an additional marginal.

The evaluation will follow the steps illustrated in Figure 20 below.

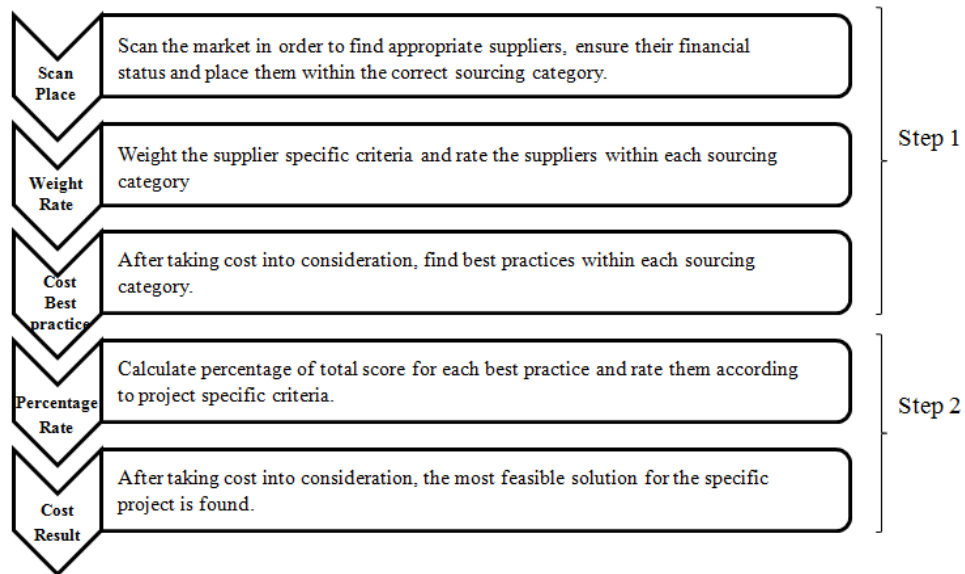
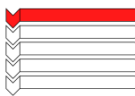


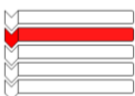
Figure 20. Flow chart of the evaluation process

 Firstly, the market is scanned for appropriate suppliers. Steffen Rohwer, Head of Wind Plant Procurement, E.ON Climate & Renewables, sent out invitations to tender to some suppliers on the market in Q4 2010, and received tenders with suggested prices. These prices will be taken into consideration in the evaluation, although treated with secrecy. The authors have estimated the possible financial savings to between 200 and 600 kEUR, using a 3PL solution. However, the total cost outcome is hard to determine, since a thorough review of the final tenders needs to be performed. A full list of identified suppliers of transportation and/or installation services operating in the area can be retrieved in Appendix 3.

Tender prices have been received from the following suppliers;

- Baltship (offers transportation and installation services)
- Deugro Danmark (offers transportation)
- Universal Transport (offers transportation and installation services)
- Blue Water Shipping (offers transportation)
- Total Wind (offers installation services)
- Nordic Crane Wind (offers transportation and installation services)
- Mammoet/Kranringen (offers transportation and installation services)
- Pekkaniska (offers installation services)
- DAKO Worldwide (offers transportation and installation services)

The suppliers only offering one service (transportation or lift/installation) will be regarded by reviewing the possibility of combining the two. The financial situation of these suppliers is presumably satisfactory, but this is however something that needs to be further reviewed by a suitable person. The turbines used in the Knäred project will be Vestas V-90 2 MW turbines; hence Vestas pose as the full turnkey alternative.

 The supplier specific criteria have been weighted by Magnus Axelsson, Head of Construction, E.ON Vind Sverige AB, and Mats Egard, Project Manager, E.ON Vind Sverige AB on April 12th 2011 as seen in Table 11 below. Note that the weighting reflects E.ON Vind's situation today and will most likely change over time. Axelsson and Egard decided to combine CSR and brand in order to facilitate the weighting, since they did not consider these criteria to be of great essence in E.ON Vind's current situation regarding sourcing services. By being an experienced actor within this area, Axelsson and Egard considered safety and quality to be partly included in the criteria regarding the supplier's experience.²²⁶

²²⁶ Axelsson & Egard, discussion (2011)

Table 11. Weighting supplier specific criteria, E.ON Vind

Criteria	Weighting, E.ON Vind
Experience	30%
Safety	20%
Quality	10%
CSR/Brand	5%
Flexibility	30%
Relationship	5%
Total sum	100%

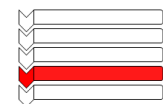
The suppliers were thereafter evaluated according to the questions within each supplier specific criteria and rated after performance. Information has been retrieved from the suppliers' websites and by contacting the suppliers personally. More detailed tenders have been received from Baltship, Universal Transport, Total Wind and Nordic Crane Wind, where some additional information could be collected. However, the information regarding Baltship is solely based on their webpage and tender due to lack of personal contact. This will hence affect their rating negatively. Mammoet/Kranringen had to be eliminated from the evaluation because of inability to initiate contact.

For a full rating, and answers to the questions that constitute the foundation of this rating, see Appendix 4. The authors were unable to answer some of the questions (marked with *) due to lack of information and inability to negotiate the tenders.



After rating the suppliers according to the supplier specific criteria and taking cost into consideration, the following suppliers are regarded as best practices within their sourcing category;

- Blue Water Shipping – Transportation
- Nordic Crane Wind – Lift and installation
- Nordic Crane Wind – Transportation, lift and installation
- Baltship – Transportation, lift and installation
- Vestas – Full turnkey



In order to ensure that the total score from Step 1 is taken into consideration, a relation between best practices is accounted for. The percentage calculated is then used as a weighting of the total score to find a definitive winner. The scores of the chosen best practices are added together and translated into a percentage for each best practice. In this case, the result is presented in Table 12 below.

Table 12. Percentage of total score

TOTAL SCORE = 3 380 (695+655+655+535+840)	
Blue Water Shipping – Transportation	695/3 380=21%
Nordic Crane Wind – Lift and installation	655/3 380=19%
Nordic Crane Wind – Transportation, lift and installation	655/3 380=19%
Baltship – Transportation, lift and installation	535/3 380=16%
Vestas – Full turnkey	840/3 380=25%

Thereafter, the best practices are rated according to the project specific criteria in each sourcing alternative, with the underlying questions taken into consideration. Answers to these questions, along with the actual rating, is found in Appendix 5.

As theory regarding logistics services states, the degree of complexity is influenced by the number of services provided by the suppliers and the tangibility of these services. The risks that can occur are dependent of the complexity, hence the number of suppliers. Therefore, the risks that E.ON Vind have to bear vary between the different sourcing categories. These risks, discussed further below, are reduced the more responsibility that is transferred to the suppliers. When studying the full turnkey alternative, Vestas bear nearly all the potential risks that can occur from E.ON Vinds perspective. Note that the non negotiable risks, such as flooding and fire, are unavoidable for E.ON Vind. However, the probability of these incidents occurring is not high.

Below, a further discussion regarding how these risks take shape within the different sourcing categories is presented. Costs and benefits will be taken into consideration as far as possible.

Control and responsibility distribution

There are different aspects for E.ON Vind to consider within the sourcing categories when it comes to control and responsibility distribution. The responsibility distribution is somewhat complex and it is important to consider incoterms when the arrangements in the contract are being discussed. When using a 3PL solution, E.ON Vind have control over the coordination on the project site. If two suppliers are used E.ON Vind might need to be, beyond controlling the coordination, responsible for the interface between the transportation and lift/installation companies, depending on the final agreement. It is essential for E.ON Vind to regard the two suppliers' ability to cooperate, in order to eliminate misunderstandings and increase flexibility. When choosing the full turnkey solution which Vestas offer, there is only one company that E.ON Vind can hold responsible, which simplifies the responsibility distribution. On the other hand E.ON Vind barely have any control on the project site or over the logistical process.

Figure 21 below illustrates how the control and responsibility differ between the different sourcing alternatives.

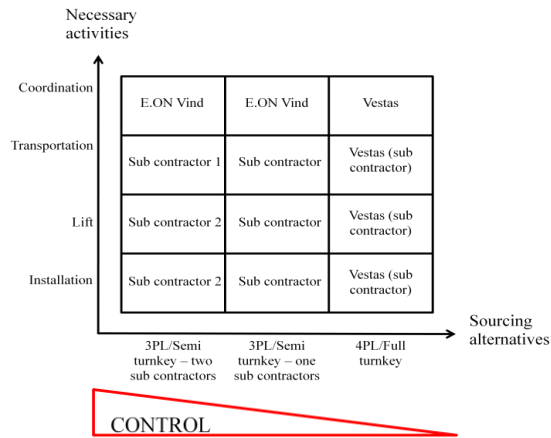


Figure 21. Control and responsibility within different sourcing alternatives

Interfaces

The more interfaces, where unloading/reloading/offloading needs to be performed, the higher is the risk factor. Depending on the sourcing alternative, E.ON Vind can be held more or less accountable for possible accidents that can occur in these interfaces. The flexibility of the supplier, as well as the negotiated terms, control the responsibility. If choosing to combine two suppliers, the number of interfaces is higher than if only one supplier or a full turnkey solution is chosen. Consequently, depending on the agreement, the number of interfaces decreases the more responsibility that is delegated out to the suppliers. Regarding the full turnkey alternative no interfaces, from E.ON Vind's perspective, exists.

In Figure 22 below, the number of interfaces related to the risk factor is illustrated for the different sourcing alternatives.

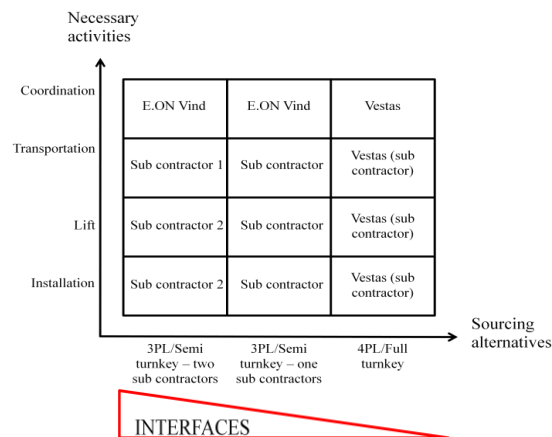


Figure 22. Interfaces and risk factor within different sourcing alternatives

Risk for delays and standstill (unavoidable)

Unavoidable risks are impossible to rate in E.ON Vind’s current situation, where no final tenders are submitted. Regulated agreements after negotiation concerning unpredictable scenarios such as accidents, harsh weather conditions and fire, may change the cost situation tremendously. The supplier must have the financial capabilities to bare the risks, which is taken into consideration before performing the first step of the evaluation. However, it is still E.ON Vind who are ultimately affected since delays and standstill lead to a loss in production.

Resources

The resources that need to be acquired, increases in number and cost depending on E.ON Vind’s involvement in the logistical process. When the company is responsible for the coordination they might need to offer the suppliers’ tools, sheds and offices depending on the agreement. E.ON Vind must also add site managers for coordination. When choosing a full turnkey solution, Vestas is ultimately responsible and E.ON Vind must only add resources for controlling how the project proceeds.

The variation in the resources that need to be added on site, is illustrated in Figure 23 below.

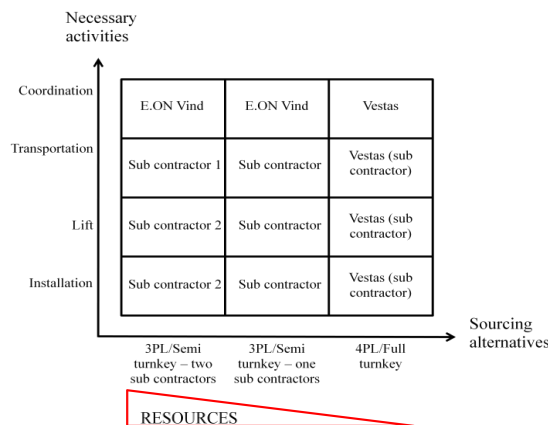


Figure 23. Resources needed within different sourcing alternatives

The additional costs that arise regarding the 3PL-alternatives are as follows;

Personnel costs

The employee with the coordinating responsibility on the project site must be accessible 12 hours a day, 6 days a week. Two employees share this role, thus this will not affect the total cost since their working hours do not overlap. The expected cost to hire a consultant to perform this activity is 700 SEK/hour. In the Knäred project, which has an estimated construction duration of 12 weeks, the total coordinating cost for E.ON Vind would sum up to 600 kSEK. Compared to the full turnkey alternative, where E.ON only have to visit the site for about 12 hours a week in order to oversee the project, the total cost sums up to 100 kSEK

(using 700 SEK as an hourly rate).²²⁷ Consequently, an additional 500 kSEK needs to be added to the 3PL alternatives in coordination costs in order to make the alternatives equal.

Regarding unloading/reloading/offloading, E.ON Vind is likely to be responsible for the supervision and coordination when using a 3PL solution²²⁸. It is, in the current situation, impossible to estimate these costs, since it can vary between different sub contractors and the planned route for transportation. The amount of work might also include the rent for appropriate equipment, such as cranes, and personnel performing the work.

Note that additional procurement costs also need to be added when performing this evaluation in future projects.

Equipment costs

There are additional equipment costs that might vary between different suppliers and sourcing alternatives. When choosing a full turnkey solution, all the necessary equipment, regarding sheds for personnel and offices, tools, etcetera are included in the negotiated price. When selecting a 3PL solution it is important to find out if the suppliers can provide the necessary equipment. Otherwise this must be bought by E.ON Vind or rented by the manufacturing company (in this case Vestas). Recommendations and regulations from the Swedish Work Environment Authority must be followed to ensure a satisfactory work environment. The responsibility for the equipment needed might be divided between E.ON Vind and the manufacturing company, depending on the agreements with the suppliers. Potential companies to rent the equipment from are CRAMO, Ramirent, and Hyrex. Assarsson (2011) estimates the equipment needed for a project with 10 Vestas V-90 turbines, in an environment like Knäred to be;²²⁹

- Two sheds for personnel
- One office trailer
- A number of containers
- Two generators (one large and one small)
- Diesel depot with pump
- Waste containers
- Environmental container
- Boom lift (similar to an off-road forklift)
- Aid kits
- Fire equipment
- Steel sheets underneath trailers/sheds/containers
- Alarm equipment

²²⁷ Axelsson & Egard, discussion (2011)

²²⁸ Assarsson, telephone interview (2011)

²²⁹ Ibid.

It is recommended for E.ON Vind to conduct a site control with the sub contractor's site supervisor/manager, who will work on the project site, in order to control and ensure exactly which equipments that are needed for the specific project.²³⁰ Ove Karlsson, CRAMO, estimated the cost of the following equipment to 125 kSEK (calculated on a total of 12 weeks), with a reservation that this is only an approximate price indication that needs to be further discussed; two sheds for personnel, one office trailer, three containers, one large and one small generator, diesel depot with pump and boom lift.²³¹

A 20 foot environmental container with side doors costs about 2 kSEK per month, hence 6 kSEK for three months²³². Regarding the waste containers, these are needed for wood, combustible material and cables/metal. The cost for four containers à 10 cubic meters is approximately 20 kSEK including delivery to site, waste discharge and disposal of the waste.²³³ Additional costs for purchasing of aid kits and fire equipment reside, but do not amount to any substantial costs. The authors estimate this cost to 5 kSEK.

The Swedish Transport Agency also has regulations to follow concerning construction works on WTGs. From the moment that the first blade is installed, flight lights must be ignited after dark falls. The cost is estimated to 1.5 kSEK/day (including rent, diesel, and personnel), resulting in a total cost of 126 kSEK (calculated on a total of 12 weeks) for Knäred.²³⁴

The importance of addressing these questions before signing the final contracts is essential, as they may be decisive in the final choice of suppliers. Renegotiations are something that can reduce these costs, since equipment can be incorporated into the final price. The approximate cost for the necessary equipment, if E.ON Vind were to rent everything themselves, is 300 kSEK.

Insurance

If E.ON Vind decide to handle transportation and installation services themselves, an additional insurance cost also arises. Ulf Berggren, Head of Corporate Group Insurances, E.ON Sverige AB, estimates the insurance cost for transportation, lift and installation of wind turbines to between 50 and 100 kSEK.²³⁵

²³⁰ Assarsson, telephone interview (2011)

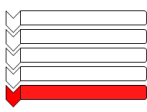
²³¹ Karlsson, email conversation (2011)

²³² Containerpoolen, telephone conversation (2011)

²³³ Haga Mölndal Lastbilscentral, telephone conversation (2011)

²³⁴ Assarsson, telephone interview (2011)

²³⁵ Berggren, conversation (2011)



Lastly, after reviewing the costs of the different alternatives once more, the authors' recommendations to E.ON Vind are as follows. Based on the information accessible to the authors, Vestas is the most feasible solution for Knäred.

If E.ON Vind were to proceed negotiations with any of the 3PL suppliers, the authors recommend a further investigation of Baltship. Baltship did not receive top ratings, mainly due to lack of information. However, they did receive a high rating where satisfactory information was available. This, in combination with a competitive price, makes Baltship an interesting alternative. Approximate costs residing to a 3PL solution are presented in Table 13 below.

Table 13. Approximate costs residing to a 3PL solution

Possible savings	(+) 2 000-6 000 kSEK (200-600 kEUR)
Personnel costs	(-) 500 kSEK
Equipment costs	(-) 300 kSEK
Insurance costs	(-) 50-100 kSEK
Contingency	(-) 400-500 kSEK
Total sum	(+) 600-4 750 kSEK

As Table 13 shows, there are possible savings of 600 and 4 750 kSEK depending on the outcome and choice of supplier. The contingency cost taken into consideration will be reduced as E.ON Vind gain more experience and knowledge within the area of coordinating these types of services. Hence the possible savings will increase as E.ON Vind coordinates more project. Another aspect that is important to regard is the fact that larger projects generate a higher saving than the smaller ones.

Although there are possible savings concerning the use of a 3PL solution, Vestas is the recommended alternative for the Knäred project. This is mainly due to the fact that there are still many uncertainties regarding the project, as well as an already constraint time frame. However, the authors suggest that E.ON Vind make use of the 3PL solution (using one sub contractor) in an upcoming project. This should favorably be a smaller project, in order to take advantage of the gained experience and knowledge in a larger project in the future.

Factors to consider while negotiating with 3PL suppliers

It is important to consider the following while negotiating with 3PL suppliers, if E.ON Vind decide to start coordinating transportation and installation services;

- Have as little responsibility over interfaces as possible.
- Negotiate the responsibility distribution for different occurrences that can take place. This can be done by adopting incoterms and insurances.

- The arrangements regarding tools, sheds, offices, etcetera are also a factor that needs to be taken into consideration when putting the final agreement together.
- The number of wind days (standstill due to wind) that are included in the final agreement.

There are some aspects that the authors have been unable to perform, but are fundamental to assure before choosing a supplier;

- Perform quality inspections of previous projects, in order to ensure that the chosen supplier is competent. This is preferably done by contacting references.
- It is also of essence for E.ON Vind to request for a supplier pre-qualification questionnaire, to assure the health and safety practices of the supplier. This questionnaire also takes technical and financial capabilities into consideration.

7.4.1 Conclusions regarding possibilities and risks

The authors have come to the following conclusions regarding possibilities and risks if E.ON Vind were to start coordinating transportation and installation services of their wind turbines, hence using a 3PL solution.

Possibilities

By taking over the responsibility for coordinating transportation, lift and installation on the project site E.ON Vind can take advantage from the following possibilities;

- *Financial gain:* When reviewing the not yet negotiated prices they indicate that there are possible financial gains to be made from using a 3PL sourcing alternative. However, it is important to consider the personnel and equipment costs that are added on to these prices.
- *Control on site:* As earlier stated, the more responsibility E.ON Vind take on, the more control on site will be attained. From a safety point of view this is a great possibility for E.ON Vind to ensure that the suppliers follow their HSSE-plan. As opposed to working with the manufacturing company (e.g. Vestas), the company now has the authority to communicate directly with the suppliers performing transportation and installation services.
- *Develop the organization:* By transferring more responsibility to E.ON Vind, it will contribute to organizational learning. Although it might be best to hire consultants to coordinate the activities at first, this is something that can be performed by the existing employees in the future.

Risks

However, there are certain risks that also are important to take into consideration before making the decision regarding the use of a 3PL sourcing alternative;

- *Unpredictable costs*: Apart from the personnel and equipment costs mentioned in “Financial gain”, factors that cannot be negotiated into the agreement or that E.ON want to add (e.g. insurance or incoterms) can result in additional costs. Moreover, unpredictable costs due to unavoidable risks when transporting and performing lift and/or installation services of the turbine components might also occur. Examples of these unavoidable risks are accidents along the transportation route, bad weather conditions (snow and ice) and wind strengths exceeding allowable level.
- *Number of interfaces*: As earlier stated, the number of interfaces that E.ON Vind have to answer for increases the more responsibility the company takes on. This is however something that can be negotiated with the suppliers, consequently adding additional costs to the price.
- *More resources*: Even though coordinating transportation and installation services will contribute to the development of the organization, it will also require more resources to do so. The risk is that the project may require more resources or time than expected, due to lack of knowledge and previous experience.
- *Contractual gaps*: Since E.ON Vind never have performed this type of service before, it is essential that an attorney-at-law specializing in this type of area review the final agreement before it is signed. Otherwise there is a risk that contractual gaps contribute to disagreements regarding responsibilities and costs.
- *Negotiation situation*: E.ON Vind’s negotiation situation is most likely not as advantageous as the manufacturing companies, since the WTGs previously have been bought full turnkey. However, the relationships with the suppliers of transportation and installation services are something that will improve over time. This is an initial risk that will emerge no matter when E.ON Vind decides to take on more responsibility.

7.4.2 Possible implications on the process map

There will be no implications on the process map if a full turnkey solution is chosen, since it reflects the current situation. If choosing a 3PL solution, E.ON Vind will have more responsibility on the project site where they handle the coordination. The activities in the following sub processes; *Lead, follow up and report construction activities*, *Prepare the construction start*, and *Monitor and coordinate construction* will hence be affected. These sub processes will need to be more detailed as they will have a larger impact on the overall project. E.ON Vind will be involved earlier in the process and must take the same responsibility as the manufacturing company does in the current full turnkey solution.

The activities carried out in the sub process *Prepare the construction start*, i.e. hold an introductory meeting as well as a coordination meeting, will need to be more essential and detailed, since E.ON Vind will be in contact with more sub contractors than before. Regarding *Lead, follow up and report construction activities*, the activity “lead project” will involve more responsibility for E.ON Vind, as they will have the primary responsibility on the project site. The increased responsibility will also affect “monitor the construction job on the site”, which is an activity in the sub process *Monitor and coordinate construction*. The activity “coordinate contractors” will also be more complex, since E.ON Vind will have multiple sub contractors involved in the project. The content of this activity will vary depending on the number of sub contractors used.

Within the sub process *Sign contracts and possibly end negotiate with suppliers* the increasing number of negotiations will demand more knowledge and a more thorough preparatory work must be done. The SAWPS-model should act as a guideline and facilitating tool for the purchasing manager and all internal stakeholders involved.

A sourcing evaluation model for transportation and installation services of wind turbines

8. Conclusions and final remarks

In this final chapter, the conclusions and contributions with regards to the purpose and objectives of this thesis are presented. Thereafter, the general applicability of the results is discussed. Lastly, final remarks concerning potential improvements and areas for further research are given.

8.1 Conclusions and contributions

The purpose of this study was to contribute to a deeper knowledge about the process of selecting sources of supply for transportation and installation services for wind turbine generators (WTGs).

In order to achieve the purpose, the three objectives presented below were set;

- To identify and describe the necessary activities for and the challenges associated with transportation and installation services of WTGs.
- To develop a general evaluation model for the sourcing alternatives for transportation and installation services of WTGs.
- To adapt the general evaluation model to E.ON Vind, and apply it to the Knäred project.

Below, the authors' contribution to the knowledge about the process of selecting sources of supply for transportation and installation services for WTGs is presented divided into the set objectives.

8.1.1 Necessary activities and challenges

8.1.1.1 Necessary activities and sourcing alternatives

A WTG is divided into components, which are usually produced at factories in different countries. After the WTGs have been transported to the project site, the simultaneously occurring activities regarding lift and installation begin. During the entire process, from manufactured to commissioned WTGs, coordination is essential. It is important that all activities regarding transportation and installation services are coordinated to make the process as efficient as possible. The necessary activities identified from manufactured to commissioned WTG are hence *transportation, lift, installation* and *coordination*, which are presented in chapter 4.2.

There are several alternatives regarding sourcing that are applicable in this thesis; *make yourself, make and buy, 3PL/semi turnkey* and *4PL/full turnkey*. These are identified in chapters 3.2 and 4.3. When producing something in-house, the firm better understands the good or service and takes advantage of their own expertise. Make yourself can be viewed as internal sourcing, since resources within the

company is utilized. Firms can also simultaneously make and buy services at the same time, where a part of the service is performed in-house and the other part is bought from an outside supplier. In 3PL/semi turnkey one or several civil contractors are responsible for the execution of all civil works for the plant, infrastructure and to provide warranties. The purchasing company is mainly responsible for the coordination between main contractor and civil contractors. A 4PL/full turnkey solution means that a single contractor acquires and sets up all premises, equipment, supplies and operating personnel to bring a project to operational readiness.

To illustrate which of the necessary activities that are performed by who in different sourcing alternatives, Figure 24 below was created by the authors – firstly presented in chapter 5.1.

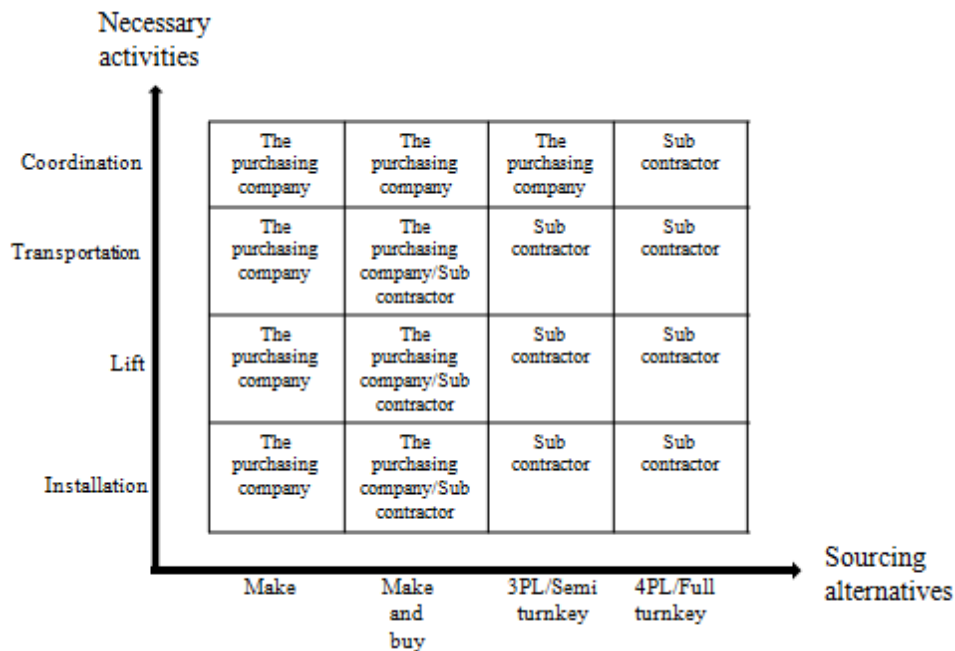


Figure 24. Potential sourcing combinations

8.1.1.2 Challenges

While the market opportunities for transportation and logistics providers are growing there are challenges that, if left unaddressed, will create obstacles to achieving the wind energy industry's full potential.

Among the key transportation and logistics challenges impacting all modes of transport are:

- Height, weight, width, and length limitations.
- The growing size and weight of wind turbine blades, towers and nacelles, which may exceed the physical capacity of existing equipment.
- The limited number of truck trailers capable of transporting turbine components.
- The growing transportation and logistics costs contributing to price pressures in wind energy development (such costs can add 10-25% to the cost of a turbine).

Challenges considering lift and installation of the WTGs are the areas needed for the lifting operation, the need for wide roads inside parks, the rigging between turbine sites, the wind restrictions (maximum 5-8 m/s during lifting) and the cost for mobilization and hire, especially of the largest units.

The challenges regarding transportation, lift and installation of WTGs are presented in its entirety in chapter 4.2.

8.1.2 The general sourcing evaluation model (the SAWPS-model)

Supplier and project specific criteria

Before creating the actual model, key factors were recognized in chapter 4.4 and 4.5. In chapter 5.2 these key factors were divided between supplier and project specific criteria. These criteria constitute the foundation and are used as evaluating factors in the model created in chapter 5.3 and adjusted in chapter 6. The supplier specific criteria are directly connected to the suppliers' performance and are easier to affect. The criteria that are project specific are associated with the sourcing situation and these are connected to a specific project.

The key factors, divided into supplier and project specific, are presented in Table 14 below.

Table 14. Supplier and project specific criteria

Supplier specific	Project specific
Experience	Control and responsibility distribution
Safety	Interfaces
Quality	Risk for delays and standstill (unavoidable)
CSR	Resources
Brand	
Flexibility	
Relationship	

In order for the purchasing company to enter into an agreement with a supplier, a stable financial situation is a necessity. Therefore, the supplier’s financial situation is reviewed before entering the evaluation model. The cost of the offer is reviewed twice (after each step), since this factor has a large impact on the final decision.

Sourcing alternatives of wind power services – the SAWPS-model

With theory concerning MCDA and SSMS as a foundation, the SAWPS-model for choosing the right supplier within the right sourcing alternative for a specific project was created. Figure 25 below illustrates the work flow – from scanning the market until the most feasible solution for a specific project is found. For a more detailed description, see 6.2 Final version of the SAWPS-model.

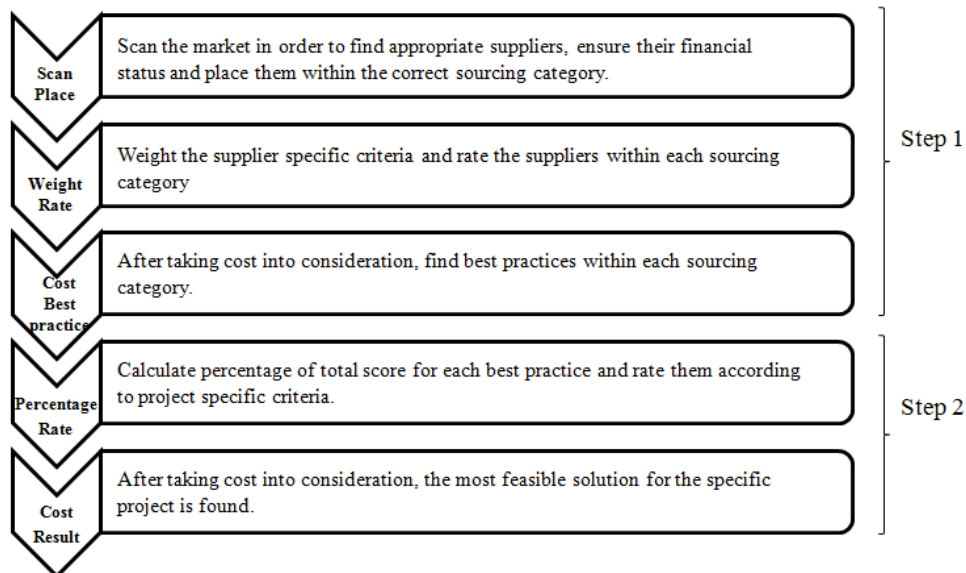


Figure 25. Flow chart of the evaluation process

8.1.3 Learnings from applying the SAWPS-model to Knäred

Based on E.ON Vind's current situation regarding sourcing alternatives for transportation and installation services, Figure 26 below was created in chapter 7.4. This illustrates the different sourcing alternatives relevant to E.ON Vind and who performs the necessary activities in each alternative.

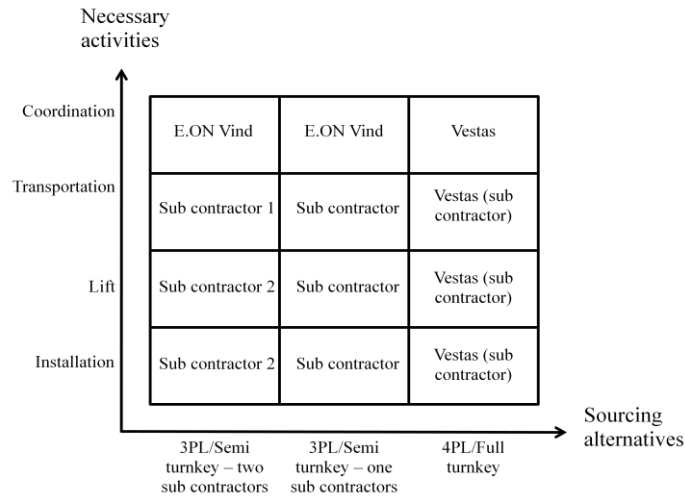


Figure 26. Potential sourcing alternatives, adjusted to E.ON Vind

After evaluating the alternatives through the SAWPS-model, presented in chapter 7.4, the authors' believe that Vestas is the most feasible solution for Knäred, based on the information accessible.

If E.ON Vind were to proceed negotiations with any of the 3PL suppliers, the authors recommend a further investigation of Baltship. Baltship did not receive top ratings, mainly due to lack of information. However, they did receive a high rating where satisfactory information was available. This, in combination with a competitive price, makes Baltship an interesting alternative.

Although there are possible savings of 600 and 4 750 kSEK concerning the use of a 3PL solution, Vestas is the recommended alternative for the Knäred project. This is mainly due to the fact that there are still many uncertainties regarding the project, as well as an already constraint time frame. However, the authors suggest that E.ON Vind make use of the 3PL solution (using one sub contractor) in an upcoming project. This should favorably be a smaller project, in order to take advantage of the gained experience and knowledge in a larger project in the future.

With regards to the presented findings, the objectives of this thesis are considered to be well accomplished and so also the purpose.

8.2 The general applicability of the results

The SAWPS-model created in this thesis has its theoretical foundation within the MCDA and SSMS theories, although the structure of the evaluation model as well as the key factors are compiled by the authors. Therefore, it is important to note that the SAWPS-model is of subjective nature, which is true for all MCDA-inspired models.

The model evaluates both supplier and project specific criteria within the different sourcing categories possible, in order to present the most feasible solution for a specific project regarding supplier and sourcing alternative of transportation and installation services of wind turbines. The criteria were developed by interviewing actors within the wind power industry and reviewing existing evaluation models within the area of supplier evaluation and selection. Lastly, the evaluation model was adjusted after interviewing people within different segments of the business world. The SAWPS-model is considered to be purposefully useful and applicable when choosing sources of supply within transportation and installation services of WTGs.

The SAWPS-model can be generalized, which is strengthened by the fact that input from multiple segments within the business world is taken into consideration when adjusting the model. Parallels can be drawn to other industries where complex transportation, lift and/or installation situations occur, such as the building industry (larger projects such as building bridges or tunnels). Because of the weighting of the different key factors performed in Step 1, their importance can be affected by the purchasing company regardless of operative industry. Consequently, the SAWPS-model takes different opinions and different influences into consideration. In a wider perspective, smaller freight companies can use the evaluation model, or at least the key factors, as inspiration when they face larger and more complex assignments.

Parallels can also be drawn to Lee, Ha & Kim's (2001) SSMS, presented in the theoretical framework. This framework can be applied to any manufacturing company when evaluating suppliers. Comparing the steps of SSMS and the developed SAWPS-model, they follow a similar structure – both focusing on finding the optimal supplier for a specific project. The major difference between the two models is that SSMS focuses on parts, whereas the SAWPS-model focuses entirely on services. This affects the formation of the criteria and the evaluation result, since the SSMS criteria are easier to quantify due to its tangibility.

The foundation for both models is the theory regarding MCDA although SSMS uses AHP to perform the rating, which is a more complex MCDA rating system than the one presented in the SAWPS-model. Both models propose to ease the

purchaser's task of selecting and managing each supplier. The fact that SSMS is an accepted framework also strengthens the generalizability of the SAWPS-model.

8.3 Final remarks

8.3.1 Potential improvements

The area where most improvements can be made is within verifying and validating the SAWPS-model further than what has been performed in this thesis.

The compiled evaluation criteria and the adjustments made to the model before presenting the final version rely on the opinions of experts, mostly within the wind power industry. While compiling the key factors it would have enhanced the thesis' credibility if some of the interviewees were outside of the wind power industry. This is somewhat compensated by letting people from several industries review the model. However, it would have been of value to the study if a more diverse selection of experts were interviewed. The number of interviewees is limited due to several aspects, e.g. a limited timeframe for conducting the study and interviewees either being unreachable or unidentifiable.

In addition, it would have been validating to use more quantifiable facts when applying the SAWPS-model to the Knäred project. Since the authors are not in the position to negotiate tenders from the suppliers, this would have been hard to achieve.

8.3.2 Suggestions for further research

The subject of transportation and installation services of WTGs is wide and complex. Today, most purchasing companies buy turnkey solutions regarding these services from the manufacturing company. In a general perspective, the wind power industry in Sweden is highly on the subject due to the government's national plan to increase the total production to 30 TWh in 2020. Transportation and installation services is hence an area that will grow as the number of wind power projects increases. Therefore, it is important to retrospectively evaluate and study the outcome after the SAWPS-model has been applied to and exercised on a real project. Depending on the results, potential additional adjustments might be needed.

After using the SAWPS-model on a sharp project it is also possible, given that it is not the 4PL alternative that is found to be the most feasible, to compare the final cost against the cost provided by the manufacturing company. Thereafter, it is also easier to quantify further than performed in this study. It is also of interest to compare the negotiated price with the actual outcome, and analyze the reasons why a possible difference came about.

It would also be of interest to further study the market aspect of this thesis. What will happen on the market if the purchasing companies focus more on the activities of transportation and installation services themselves?

When the SAWPS-model is to be applied on different areas than the wind power industry, an exploratory study needs to be performed in order to assure the relevance of the evaluation criteria within the selected business.

8.3.3 Epilogue

Spending the semester at a company in the business world has taught the authors many things about the adjacently future approaching. Among some of the learnings is the importance of establishing long- and short-term goals between both colleagues and the department of which you are a part of.

Also, it has been interesting and challenging writing about an unexplored area – combining an upcoming logistical challenge in the wind power industry with the problematic of choosing the appropriate supplier and sourcing alternative for a service.

Even though E.ON Vind will not use a 3PL solution for the Knäred project, the authors believe that the SAWPS-model will be used in future projects.

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Appendix 1. The foundation of the adjustments conducted to the SAWPS-model

Table 1. Compiled answers from interviews

Interviewee, date	Title, company	Potential improvements recognized by the interviewees	Actions taken by the authors
Johan Andersson, 2011-04-05	Purchasing and logistics, Peab	Financial status, penalty and warranties are elements that should be considered within the supplier specific criteria.	Criterion regarding financial status is added.
		Secure the use of references when ranking the different suppliers to reduce the subjectivity.	Information taken into consideration when updating the questions.
		Consider to weight the project specific criteria in the second step of the evaluation model, in order to make the result justifiable.	Not taken into consideration. The authors believe that the project specific criteria are equally important. If desired, they can be affected by the rating.
		Simulate worst/best/normal case situations and take these into consideration when choosing appropriate supplier.	Information regarding worst/best/normal case situations is added.
		Describe how to conduct a market survey.	Market survey is changed to scan the market for potential suppliers. Information regarding the execution is added.
Magnus Axelsson, 2011-04-05	Head of Construction, E.ON Vind Sverige AB	Financial status should be considered within the supplier specific criteria. The suppliers that do not fulfill the financial requirements should not be evaluated.	A criterion regarding financial status is added. The suppliers' financial status will be evaluated before placing them in the right sourcing category.
		Make the identified key factors more explicit. Describe how to handle risks and the potential consequences.	Information taken into consideration when updating the questions.

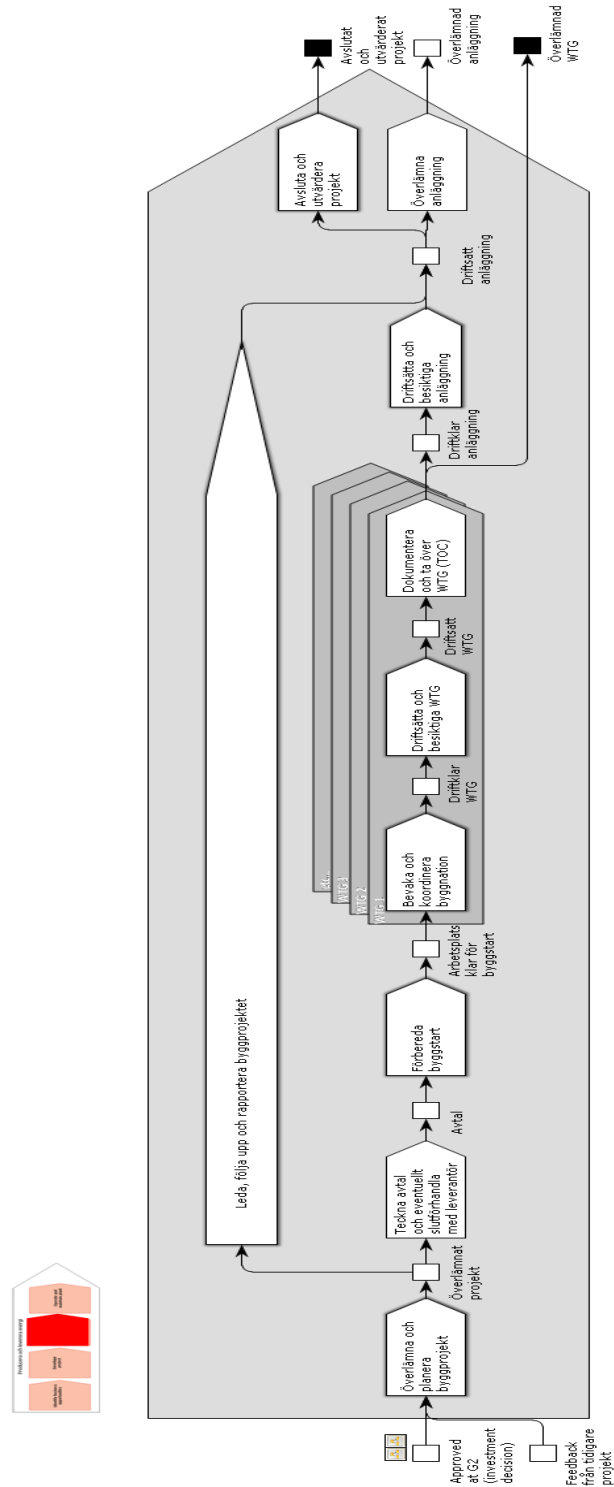
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Per Brännström, 2011-04-04	Project Manager Construction, Grontmij AB	Make sure that the image of a certain supplier does not impact the calculated percentage in the second step of the evaluation model. Otherwise, there is a possibility that the project specific criteria do not get the right penetrating power.	Information taken into consideration when updating the questions.
		Consider to apply a factor on the sourcing categories in the second step of the evaluation model, in order to make the result justifiable.	Not taken into consideration. Will however be addressed as a potential improvement area.
Magnus Franck 2011-04-06	Vice President Supply Chain Management, Vestas Northern Europe	The suppliers' financial ability to carry out the risks needs to be taken into consideration as a criterion.	A criterion regarding financial status is added.
		Verify the certification of the suppliers' equipment and employees and customize it to each unique project.	Information taken into consideration when updating the questions.
		Determine the procurement competences within the purchasing company to ensure a fair assessment, both regarding the weighting and the rating.	Not taken into consideration. Will however be addressed as a potential improvement area.

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<p>Gunnar Fredriksson, 2011-04-06</p> <p>Mattias Wondollek, 2011-04-06</p>	<p>Vice President, Svensk Vindenergi</p> <p>Project Manager, Svensk Vindenergi</p>	<p>Enhance the importance of environmental issues.</p>	<p>Is taken into consideration within the criteria addressing CSR.</p>
		<p>Clarify the different parameters that need to be taken into consideration when comparing different means of transportation. Are these comparable?</p>	<p>Information taken into consideration when updating the questions.</p>
		<p>Clarify that subjectivity values affect the outcome.</p>	<p>Information regarding subjectivity is added.</p>
		<p>Clarify the difference between supplier and project specific criteria.</p>	<p>The difference is clarified.</p>
		<p>Consider changing the rating system, because of its subjectivity both in the actual rating and the interpretation of the result.</p>	<p>Not taken into consideration. Is prevented by updated questions and the competency of the person answering the questions.</p>
<p>Christian Stenqvist, 2011-04-01</p>	<p>Ph. D. Student, Environmental and Energy Systems Studies, Lund University</p>	<p>Illustrate the different steps in a flow chart in order to simplify usage.</p>	<p>A flow chart is added.</p>
		<p>Clarify the evaluation criteria with more detailed questions in order to facilitate the rating.</p>	<p>Information taken into consideration when updating the questions.</p>
<p>Olli Väänänen, 2011-04-14</p>	<p>Heavy cranes Manager, Pekkaniska Group</p>	<p>Make sure that the suppliers use the right equipment (machines, tools).</p>	<p>Information taken into consideration when updating the questions.</p>

Appendix 2. Process map Construction



Appendix 3. Identified suppliers

The following suppliers, active within this geographical area, have been identified by the authors;

Table 2. Identified suppliers, active within the geographical area

Company name	Services offered	Webpage
Baltship	Transportation, lift and installation	http://www.baltship.dk/
Deugro Danmark	Transportation	http://www.deugro.com/
Universal Transport	Transportation, lift and installation	http://www.universal-transport.eu/
Blue Water Shipping	Transportation	http://www.bws.dk/
Total Wind	Lift and installation	http://www.totalwind.dk/
Nordic Crane Wind	Transportation, lift and installation	http://www.nordiccranegroup.no/kunder/ncg/cms.nsf/pages/vindkraftse.html
Mammoet/ Kranringen (KR Wind is as from January 10 th 2011 100% owned by the Mammoet Group)	Transportation, lift and installation	http://www.mammoet.com/Default.aspx?tabid=188 http://www.kranringen.no/ http://www.krwind.com/Home
Pekkaniska	Lift and installation	http://www.pekkaniska.com/fi/en/index.html
DAKO Worldwide	Transportation, lift and installation	http://www.dakoworld.com/index.php?id=9
KVN Autokrane	Lift and installation	http://www.kvn-autokrane.de/eng/index.html
Nostokonepalvelu	Transportation, lift and installation	http://www.nostokonepalvelu.fi/en
Silvasti	Transportation, lift and installation	http://www.silvasti.com/index-se
Hjordtals	Transportation	Unable to find contact information
WKA Montage GmbH	Lift and installation	http://www.wka-montage.eu/en

Appendix 4. Responses and rating Step 1

References to the information in Table 3 below can be retrieved in the reference list “Appendix 3 sources”.

Table 3. Compiled answers to questions in Step 1

	Baltship	Deugro Danmark	Universal Transport
<i>Experience</i>			
<i>Does the supplier have any knowledge from past experience?</i>	Yes, active since 1997. No information regarding the start of WTG freight.	Yes, active since 1924. No information regarding the start of WTG freight.	Yes, founded in 1953. Commencing transportation of huge cargo volumes and heavy haulage in 1970. Started to freight wind turbine components in 1998.
<i>What references does the supplier have from previous projects?</i>	Long list, Baltship have transported more than 1 000 1.6-3.0MW turbines a year during the last years.	Long list, Deugro have transported more than 1 600 turbines the last seven years.	Long list, they have performed many wind turbine projects.
<i>What type of projects has the supplier previously worked with?</i>	Baltship is one of the leading transportation companies within the wind power industry.	Deugro Danmark have worked in a number of wind turbine projects.	Universal have worked in a number of wind turbine projects. Some examples are: France - Rouen Hungary - Level Germany - Asleben Italy - San Sosterne Bulgaria - Shabla Czech Republic - Habartice Poland - Wilkopolska Romania – Fantanelle

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	Baltship	Deugro Danmark	Universal Transport
<i>What is the supplier's core competence?</i>	Management and transportation of complex and heavy load transportation.	Provider of international freight forwarding services, specializing in turnkey projects and complicated cargo moves.	Complex logistics projects.
<i>Are the supplier's personnel skilled and dedicated to the task?</i>	Yes, the personnel have a minimum of 5-6 years working experience.	Yes.	Yes, their personnel are skilled to work in this industry sector. They are only responsible for the wind energy in Universal Transport. Based on the broad experience of transporting wind turbine components, their personnel have good requirements to work in this sector.
<i>Does the supplier have a satisfying CV?</i>	*	*	*

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Safety	Baltship	Deugro Danmark	Universal Transport
<i>Is the supplier familiar with the purchasing company's HSSE-plan?</i>	*	*	*
<i>What are the supplier's safety guidelines?</i>	A Health, Safety, Environment and Quality Management System is implemented. Health and Safety Programme (OHSAS 18001:2008 certified).	A Health, Safety, Environment and Quality Management System is implemented. The system compile the three systems; ISO 9001, ISO 14001, OHSAS 18001.	The main focus in their Health & Security System is the safety for every person involved in, or that gets in contact with, their services.
<i>Are the supplier's own guidelines corresponding with the purchasing company's?</i>	*	*	*
<i>Does the supplier follow their guidelines (contact references)?</i>	*	*	*
<i>Is the supplier certified according to OHSAS 18001 and ISO 14001?</i>	Yes, certified according to OHSAS 18001:2008 and ISO 14001:2004.	Yes, certified according to OHSAS 18001 and ISO 14001	No, ISO 14001 certification is planned for 2011.
<i>Does the supplier have a system for PDCA?</i>	No information retrieved.	Yes, in their HSE&Q management system	Yes, they have a list to conclude commissions.
<i>Does the supplier risk identify their own work?</i>	Yes, a risk management program is implemented.	Yes.	Yes, they have job safety assessments.
<i>Does the supplier follow existing legislation?</i>	Yes.	Yes.	Yes.

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Quality	Baltship	Deugro Danmark	Universal Transport
<i>How satisfying is the service quality that the supplier provides?</i>	*	*	*
<i>Are there differences in cultural aspects that need to be considered?</i>	*	*	*
<i>Is the supplier ISO 9000 certified?</i>	Yes, certified according to ISO 9001:2008.	Yes, certified according to ISO 9001.	Yes, certified according to ISO 9001.
<i>What type of machines/tools does the supplier use?</i>	1 * 750t truck crane/heavy duty Lattice boom Liebherr LG1750 + 2 * auxiliary crane 100t/80t hydraulic + 1 * truck w/trailer + wheel loader	No information retrieved.	Truck, trailers and cranes.
<i>Is the supplier using competent employees for the project?</i>	Yes.	Yes.	Yes.
<i>Does the supplier use any quality measurement methods for continuous improvements, such as Quality Control Plans or Inspection and Test Plans?</i>	No information retrieved.	Yes, their HSE&Q performance and systems are monitored, measured and reviewed to assure continuous improvements.	Yes, they have their own methods according to their Quality Management system.

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CSR/Brand	Baltship	Deugro Danmark	Universal Transport
<i>Is CSR observed from the supplier's side?</i>	Yes.	Yes.	Yes.
<i>In which ways does the CSR work take shape in the supplier's organization?</i>	BaltShip Environmental System (ISO 14001:2004 certified) and Social Accountability programme (SA 8000:2008 certified).	Deugro Danmark respect UN:s declaration of Human Rights, Labour principles, Environment principles and principles of anticorruption by recognizing their responsibility in observing that these rights are respected and adhered to both Deugro and their business partners.	They sponsor some projects, for example football teams. Furthermore they visit elementary schools, to explain common risks in the traffic.
<i>Are the supplier's means of transportation environmentally friendly compared to the standard in the business (way of driving, fuel and environmental classification)?</i>	No information retrieved.	Deugro and their business partners work towards minimizing environmental pollution and encourage environmental friendly technologies.	They change their trucks regularly for equipment with the newest, environmentally friendly and low-emission engine technology. Today 75% of their fleet is using engines with EURO 5 and EEV standard. Universal Transport use route scheduling and driving training. Trained drivers can reduce their fuel consumption by 10%.
<i>Is the supplier supporting any aid organization?</i>	No information retrieved.	No information retrieved.	No, not continuously.
<i>Are the supplier's values similar to the purchasing company's?</i>	*	*	*
<i>Has the supplier been involved in any scandals in previous collaborations?</i>	*	*	*

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Flexibility	Baltship	Deugro Danmark	Universal Transport
<i>Is the supplier capable to reschedule deliveries on short notice?</i>	No information retrieved.	Yes.	Yes. Universal Transport try to find solutions together with their customers.
<i>How long is the supplier's lead time, i.e. from order to effect?</i>	No information retrieved.	No information retrieved.	Universal Transport try to prepare everything as soon as possible to meet the customers' time table.
<i>Does the supplier use any tools for route optimization?</i>	Yes, they perform country analysis, road-, site-, and port surveys.	Yes.	Yes. Map&Guide, Google Street View, EasyTrack.
<i>Is the supplier prepared to renounce conveniences to complete the project?</i>	No information retrieved.	No information retrieved.	Yes, Universal Transport try to comply with their customers' wishes as effectively as possible.
Relationship			
<i>Are there any existing relationships to build on, both regarding suppliers and employees?</i>	No.	No.	No.
<i>How have previous collaborations with the supplier worked out?</i>	-	-	-

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	Blue Water Shipping	Total Wind	Nordic Crane Wind
<i>Experience</i>			
<i>Does the supplier have any knowledge from past experience?</i>	Yes, established in 1972. Started to freight WTGs in 1995.	Yes, 2003.	Yes, 25 years experience of lifting and installation in the wind power industry.
<i>What references does the supplier have from previous projects?</i>	Long list, transportation of more than 250 turbines a year (around 50 projects).	Long list with different manufactures, such as Vestas, Suzlon, Gamesa, Bonus, Siemens, NM, Micon, Neg Micon, Danwind, WinWind, GE, Wind World and Nordex.	They erected the first windmill in Sweden in 1983. Until this day Nordic Crane Wind have lifted almost half of all wind turbines in Sweden. They are working with Enercon, Vestas, Siemens, Kenersys etc.
<i>What type of projects has the supplier previously worked with?</i>	Long list, Blue Water Shipping has transported 100% of Vestas turbines for Northern Europe the last 6 years.	Total Wind have worked in a number of wind turbine installations and service jobs. They have worked mostly with Vestas in Sweden.	Nordic Crane Wind have worked in a number of wind power projects. Recent projects are a wind farm in Eslöv with 4 WTGs and a wind farm for Siemens.
<i>What is the supplier's core competence?</i>	Offers complete transportation solutions and project management for any type of cargo.	Specialized in turnkey solutions within transportation, installation and maintenance of wind turbines.	Nordic Crane Wind AB is a subsidiary of Nordic Crane Group and focus primarily on serving the wind energy market.
<i>Are the supplier's personnel skilled and dedicated to the task?</i>	Yes, Blue Water Shipping has a long history in the oil and gas sector. The people working there are already skilled to that standard.	Yes.	Yes, long experience and high competence.
<i>Does the supplier have a satisfying CV?</i>	*	*	*

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Safety	Blue Water Shipping	Total Wind	Nordic Crane Wind
<i>Is the supplier familiar with the purchasing company's HSSE-plan?</i>	*	*	*
<i>What are the supplier's safety guidelines?</i>	A Health, Safety, Environment and Quality Management System is implemented. Blue Water Shipping have their own HSE&Q department. Safety is a top priority.	No information retrieved.	A safety management system named the HSE-binder with guidelines and procedures. The base in the system is legal and customer demands.
<i>Are the supplier's own guidelines corresponding with the purchasing company's?</i>	*	*	*
<i>Does the supplier follow their guidelines (contact references)?</i>	*	*	*
<i>Is the supplier certified according to OHSAS 18001 and ISO 14001?</i>	Yes, certified according to ISO 14001.	Yes, certified according to OHSAS 18001 and ISO 14001.	No.
<i>Does the supplier have a system for PDCA?</i>	Yes, for all projects risk assessment and method statements are made.	Yes, certified according to OHSAS 18001 and ISO 14001 that are built on the PDCA-model.	Yes. They work with targets as an example.
<i>Does the supplier risk identify their own work?</i>	Yes, for all projects risk assessment and method statements are made.	Yes, Total Wind perform risk assessment and method statements for all their own work (Hazard analysis) - for each project they issue a project specific HSE handbook.	Yes. Both on project site and preventive educations.
<i>Does the supplier follow existing legislation?</i>	Yes.	Yes.	Yes.

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Quality	Blue Water Shipping	Total Wind	Nordic Crane Wind
<i>How satisfying is the service quality that the supplier provides?</i>	*	*	*
<i>Are there differences in cultural aspects that need to be considered?</i>	*	*	*
<i>Is the supplier ISO 9000 certified?</i>	Yes, certified according to ISO 9001:2000.	Yes, certified according to ISO 9001.	No, but the work is ongoing.
<i>What type of machines/tools does the supplier use?</i>	Freight forwarding.	Standard tools. Cranes: 2 * LG 1750 + 1 * LTR 11200.	Mobile cranes.
<i>Is the supplier using competent employees for the project?</i>	Yes, there are for exaple 10 former captains working in the wind department.	Yes.	Yes, their own people.
<i>Does the supplier use any quality measurement methods for continuous improvements, such as Quality Control Plans or Inspection and Test Plans?</i>	Statistics are made after each project and on a yearly basis.	Each department has specific quality objectives which are constantly registered and evaluated to enable continuous improvements.	No, not yet.

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CSR/Brand	Blue Water Shipping	Total Wind	Nordic Crane Wind
<i>Is CSR observed from the supplier's side?</i>	Yes.	Yes.	Not yet, the demands have just been raised by some customers.
<i>In which ways does the CSR work take shape in the supplier's organization?</i>	Blue Water Shipping aims to establish a standard for ethics and integrity in compliance with the law. They have produced a document regarding CSR.	For Total Wind CSR is built-in, self-regulating mechanism whereby they monitor and ensure it is active and in compliance with the spirit of the law, ethical standards, and international norms. Their goal is to embrace responsibility for their actions and encourage a positive impact through its activities on the environment, consumers, employees, communities, stakeholders etc.	Not yet, the demands have just been raised by some customers.
<i>Are the supplier's means of transportation environmentally friendly compared to the standard in the business (way of driving, fuel and environmental classification)?</i>	Freight forwarding.	Establish and maintain environmental management system that is used as a tool to assess environmental impacts, prioritize efforts and acting environmentally conscious. To promote energy saving and environmentally friendly behavior among managers and employees in-house, by increasing awareness of environmental contexts and environmental consequences.	They try to move their cranes as little as possible (shortest ways) between their projects (both economic and environmental issues).

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	Blue Water Shipping	Total Wind	Nordic Crane Wind
<i>Is the supplier supporting any aid organization?</i>	They supported the fund-raising to the victims of the tsunami in 2005. Blue Water have also donated money to various organisations, such as Danish Cancer Society, Danish Red Cross, Danish Heart Association, Children's Cancer Foundation, Muscular Atrophy Foundation and Danish Handicap Sports. They have also contributed help through transport of humanitarian aid packages in containers and trucks to the world's hot spots.	No.	No.
<i>Are the supplier's values similar to the purchasing company's?</i>	*	*	*
<i>Has the supplier been involved in any scandals in previous collaborations?</i>	*	*	*

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Flexibility	Blue Water Shipping	Total Wind	Nordic Crane Wind
<i>Is the supplier capable to reschedule deliveries on short notice?</i>	Yes. Blue Water Shipping has a close relationship with their subcontractors and rescheduling is frequently reoccurring.	Yes.	Yes. Sometimes it is a must, conditions like weather and roads can change quickly.
<i>How long is the supplier's lead time, i.e. from order to effect?</i>	Depends on the means for transportation (sea, rail, truck) and also the geographical location.	Minimum of 1 month (depends on the order situation)	It depends on the project and the location, from a couple of hours to several days.
<i>Does the supplier use any tools for route optimization?</i>	Yes, Blue Water Shipping are the only freight forwarder that have their own Naval Architect department, which work out all difficult areas and make calculations/drawings on these.	Yes, a project specific route survey is made.	Yes, they perform a route survey every time to check that roads, bridges, inclination etc. is ok for big and heavy loads.
<i>Is the supplier prepared to renounce conveniences to complete the project?</i>	No information retrieved.	No information retrieved.	As long as safety, laws and regulations are obeyed, they will do whatever possible to finish the project in time with a high quality standard.
Relationship			
<i>Are there any existing relationships to build on, both regarding suppliers and employees?</i>	No.	No.	No.
<i>How have previous collaborations with the supplier worked out?</i>	-	-	-

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	Pekkaniska	DAKO Worldwide	Vestas
<i>Experience</i>			
<i>Does the supplier have any knowledge from past experience?</i>	Yes, they started to work with wind power projects in the early 2000.	Yes. About 90% of their activities worldwide are connected with different projects, transport of heavy and bulky, out of gauge cargo and deliveries of projects to free jobsite in overseas countries. The DAKO organization have executed transportations for wind power plants since 2005.	Yes.
<i>What references does the supplier have from previous projects?</i>	Vestas, Enercon, WinWind and Nordex.	Siemens, Man Turbo & Diesel SE, Caterpillar, Krupp Polysius AG, Loesche GmbH, Enercon, Nordex, Power Machines.	E.ON, Arise Windpower, Vattenfall, Eolus Vind, O2, Triventus AB.
<i>What type of projects has the supplier previously worked with?</i>	Pekkaniska have worked in a number of wind turbine installations and service jobs.	DAKO has worked in a number of wind turbine projects, some examples are: Erlangen Augsburg Kiel Beckum Düsseldorf Aurich Norderstedt Moscow	Vestas outsource the activities of transportation and installation services.

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	Pekkaniska	DAKO Worldwide	Vestas
<i>What is the supplier's core competence?</i>	Pekkaniska Group is the leading lifting company in Estonia, Finland, Latvia, Lithuania and Russia.	DAKO's core competence is the transportation of project cargos worldwide. They offer management, coordination of projects, transportation and free foundation deliveries.	Vestas is specialized in the manufacturing of wind turbines.
<i>Are the supplier's personnel skilled and dedicated to the task?</i>	Yes.	Yes.	Yes. Their site manager has a long experience and high competence. Vestas outsource the activities of transportation and installation services.
<i>Does the supplier have a satisfying CV?</i>	*	*	*

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Safety	Pekkaniska	DAKO Worldwide	Vestas
<i>Is the supplier familiar with the purchasing company's HSSE-plan?</i>	*	*	Yes
<i>What are the supplier's safety guidelines?</i>	Safety is number one for Pekkaniska. Everything is planned carefully before executed and everybody must use their personal safety gear. Pekkaniska have a number of checkpoints before project start. All near misses and accidents are handled within the company together with the crew and the HSE manager. The reason for the unsafe situation is identified and new safer working methods are implemented if needed.	No information retrieved.	All accidents can be prevented (target is 0 accidents). Vestas put safety first.
<i>Are the supplier's own guidelines corresponding with the purchasing company's?</i>	*	*	Yes.
<i>Does the supplier follow their guidelines (contact references)?</i>	*	*	Yes.
<i>Is the supplier certified according to OHSAS 18001 and ISO 14001?</i>	No.	Yes, ISO 14001:2009.	Yes, certified according to OHSAS 18001 and ISO 14001.

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	Pekkaniska	DAKO Worldwide	Vestas
<i>Does the supplier have a system for PDCA?</i>	Yes, company standards.	Yes. Very clear and detailed procedures are written down and applied in their Quality Management Procedure Instructions.	Yes. Vestas set specific targets, based on top level indicators, for each individual facility. Then, at regular pre-determined intervals, they follow up by assessing how they are performing against these targets.
<i>Does the supplier risk identify their own work?</i>	Yes.	Yes. The risk is identified for every project in the project scenario which is established before project start. The risk management is organized in very close cooperation with DAKO's project forwarding liability insurance.	Yes, using method statements and risk assessment on every work they perform. This is also required from the sub suppliers.
<i>Does the supplier follow existing legislation?</i>	Yes.	Yes, in Germany.	Yes.

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Quality	Pekkaniska	DAKO Worldwide	Vestas
<i>How satisfying is the service quality that the supplier provides?</i>	*	*	*
<i>Are there differences in cultural aspects that need to be considered?</i>	*	*	*
<i>Is the supplier ISO 9000 certified?</i>	Yes, certified according to ISO 9001.	Yes, certified according to ISO 9001:2008.	Yes, certified according to ISO 9001.
<i>What type of machines/tools does the supplier use?</i>	Cranes, trucks, forklifts access platforms, hydraulic tools.	They normally do not use their own equipment as they are forwarders. In central America they operate with their own heavy transport fleet.	Outsource the activities of transportation and installation services.
<i>Is the supplier using competent employees for the project?</i>	Yes, Pekkniska is constantly educating their staff.	Yes.	Yes.
<i>Does the supplier use any quality measurement methods for continuous improvements, such as Quality Control Plans or Inspection and Test Plans?</i>	No.	Yes, a QMS is used for constant reevaluation and it adaptive corrections when necessary.	Yes, Vestas use Lean 6 Sigma. The ambition is to attain a 6 Sigma quality level throughout the value chain no later than in 2015. At the end of 2010, Vestas and the vast majority of its suppliers had reached 5 Sigma.

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CSR/Brand	Pekkaniska	DAKO Worldwide	Vestas
<i>Is CSR observed from the supplier's side?</i>	Yes.	Yes.	Yes.
<i>In which ways does the CSR work take shape in the supplier's organization?</i>	<p>Pekkaniska check the backgrounds of all their subcontractors to make sure that they pay their taxes and social responsibilities.</p> <p>Pekkaniska pay salaries according to union agreement and they operate with new machines which have better emissions.</p>	<p>CSR and compliance is an important factor in the execution of the works of DAKO and has found entry into the Quality and Environmental Management System. DAKO was audited in this respect not only by TÜV NORD with respect to ISO 9001:2008 and 14001:2009 but also by important clients. All employees of DAKO have been made aware of the policy of the company in this respect.</p>	<p>Vestas joined the UN Global Compact initiative and follows the ten generally recognised principles in respect of - human rights, labour rights, the environment and anti-corruption</p>
<i>Are the supplier's means of transportation environmentally friendly compared to the standard in the business (way of driving, fuel and environmental classification)?</i>	<p>All of Pekkaniska's equipment is new and meet today's emission standards. They also try to load trucks efficiently to reduce the number of trucks needed.</p>	<p>Decisions for means of transportation subcontractors etc. are guided by quality, price, safety and environmental classification. All subcontractors used by DAKO are classified by their system. Preference is always given to subcontractors who have quality, safety, CSR and environmental systems in place.</p>	<p>Vestas have implemented a green building policy, a green car policy and a green electricity policy. All new vehicles bought or leased by Vestas must be environmentally friendly. Diesel cars with particle filters are the preferred choice, as these cars cause less pollution and CO₂ emissions than petrol-fuelled cars.</p>

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	Pekkaniska	DAKO Worldwide	Vestas
<i>Is the supplier supporting any aid organization?</i>	Yes, for example Pekkaniska donated 20 000 EUR to the children hospital's cancer ward.	Yes, the DAKO organization support aid organizations in Germany and Latin America.	Yes, they launched a Little Dreams project in 2006, which provided support and guidance to help children in rural communities achieve their educational ambitions. Vestas also organize "Health Camps" for communities near their wind farms.
<i>Are the supplier's values similar to the purchasing company's?</i>	*	*	Yes.
<i>Has the supplier been involved in any scandals in previous collaborations?</i>	*	*	*

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Flexibility	Pekkaniska	DAKO Worldwide	Vestas
<i>Is the supplier capable to reschedule deliveries on short notice?</i>	Usually yes, but it depends on when the following project using the same equipment starts.	Yes.	Vestas always try to be as flexible as possible. Flexibility is case by case handling, also depending of the nature of the reschedules, due to wind or termination of project.
<i>How long is the supplier's lead time, i.e. from order to effect?</i>	Depends on site location, equipment availability/type.	The lead time needed depends on the type of cargo, permits, preparations and commitments already made.	Depends on the project and site location.
<i>Does the supplier use any tools for route optimization?</i>	No information retrieved.	Yes. DAKO have their own technical department which also takes care of route reconnaissance and optimization, preparation for permits etc.	Yes, full route surveys and traffic management plans done for every project.
<i>Is the supplier prepared to renounce conveniences to complete the project?</i>	Yes.	Yes, the main goal of DAKO is to complete the transportation and all auxiliary services connected with a project. This policy may involve a decision to renounce advantages and conveniences.	Yes.

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Relationship	Pekkaniska	DAKO Worldwide	Vestas
<i>Are there any existing relationships to build on, both regarding suppliers and employees?</i>	No.	No.	Yes.
<i>How have previous collaborations with the supplier worked out?</i>	-	-	Very satisfying.

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Table 4. Rating Step 1

Key factors	Weighting	Transportation					Lift and installation				
		Baltship	Deugro Danmark	Blue Water Shipping	Nordic Crane Wind	DAKO Worldwide	Baltship	Total Wind	Nordic Crane Wind	DAKO Worldwide	Pekkaniska
Experience	30	210	180	210	240	210	210	240	240	210	180
Safety	20	120	160	140	120	120	120	140	120	120	120
Quality	10	50	80	60	50	80	50	80	50	80	60
CSR/Brand	5	25	35	35	25	40	25	40	25	40	30
Flexibility	30	120	150	240	210	240	120	180	210	240	180
Relationship	5	10	10	10	10	10	10	30	10	10	10
Total		535	615	695	655	700	535	710	655	700	580

Key factors	Weighting	Transportation, lift and installation				Full turnkey
		Baltship	Universal Transport	Nordic Crane Wind	DAKO Worldwide	Vestas
Experience	30	210	240	240	210	270
Safety	20	120	120	120	120	160
Quality	10	50	80	50	80	80
CSR/Brand	5	25	45	25	40	40
Flexibility	30	120	210	210	240	240
Relationship	5	10	10	10	10	50
Total		535	705	655	700	840

Appendix 5. Responses and rating Step 2

Table 5. Compiled answers to questions in Step 2

	Transportation and Lift and installation	Transportation, lift and installation	Full turnkey
<i>Control and responsibility distribution</i>			
<i>How many different suppliers are used?</i>	2	1	1
<i>Is there one supplier/coordinator responsible for the whole process?</i>	No.	Yes.	Yes.
<i>Are there any guidelines referring to when the responsibility is transferred to the next supplier (if multiple are used)?</i>	Needs to be negotiated and stated in the agreement.	Needs to be stated when transferring to E.ON Vind.	–
<i>If multiple suppliers are used – has everyone agreed with the guidelines referred to in the previous question?</i>	Needs to be negotiated and stated in the agreement.	Needs to be stated when transferring to E.ON Vind.	–
<i>Are there incoterms regulating the control and responsibility distribution?</i>	Needs to be negotiated and stated in the agreement.	Needs to be negotiated and stated in the agreement.	–

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Interfaces			
<i>How many interfaces, regarding unloading, reloading and offloading, are necessary for this project?</i>	4	4 or 0 depending on the agreement.	0
<i>How many different suppliers are used?</i>	2	1	1
<i>What does the timeframe look like – are the suppliers flexible?</i>	No information.	No information.	No information.
<i>How does the supplier handle possible delays – what costs reside?</i>	Tender.	Tender.	Tender.
Risk for delays and standstill (unavoidable)			
<i>Does the supplier have any back-up plans for how to deal with unexpected occurrences such as harsh weather conditions, heavy traffic or accidents along the transportation route?</i>	No information.	No information.	No information.
Resources			
<i>Are there many resources that the purchasing company must add on site or concerning the overall coordination?</i>	72h/week.	72h/week.	12h/week.
<i>Are the necessary resources available at the purchasing company?</i>	Maybe.	Maybe.	Yes.
<i>Is there any equipment that needs to be added on site?</i>	Depending on the agreement; sheds, tools etc.	Depending on the agreement; sheds, tools etc.	No.

Table 6. Rating Step 2

	Transportation	Lift and installation	Transportation, lift and installation		Full Turnkey
Key factors	Blue Water Shipping	Nordic Crane Wind	Baltship	Nordic Crane Wind	Vestas
Control and responsibility distribution	4	4	4	4	2
Interfaces	4	4	8	8	9
Risk for delays and standstill (unavoidable)	0	0	0	0	0
Resources	6	6	7	7	9
Total	2,94	2,66	3,04	3,61	5