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Evaluation of Supply Base for Vestas Wind Park Projects in Finland

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Abstract

The thesis is done in cooperation with Vestas Wind Systems A/S and the Onshore Construction department and specifically focused on the growing wind energy market in Finland. Currently Vestas does not know if the material and services used at the Wind Park Construction Projects in Finland are sourced from the most suitable suppliers from an economical and sustainable standpoint. The supply base and possible benefits of using local suppliers is investigated and reviewed if there are improvements that could be made that reduce both transport costs and carbon emissions when using local supplier options.

The method in this thesis is conducted based on theories from Supply Chain Management and Sustainability Supply Chain Management to have the Supply Chain set up as efficient as possible to reduce cost and emissions. Supplier Base Evaluation and Supplier Evaluation was done to find most suitable suppliers either from registered suppliers or available in the Finnish market.

The result shows there are significant cost and emissions benefits to using local suppliers for the product categories included in the scope of research. Further Supply Base development is needed to utilize all benefits available when using local supply options.

Language: English Key words: Supply base, Supplier Evaluation, Sustainable Supply Chain Management, Sourcing

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EXAMENSARBETE

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Abstrakt

Examensarbetet är gjort i samarbete med Vestas Wind Systems A/S och Onshore Construction-avdelningen och fokuserar specifikt på den växande vindenergimarknaden i Finland. För närvarande har Vestas inte kännedom om material och tjänster som används vid deras vindparksprojekten i Finland kommer från de mest lämpliga leverantörerna ur en ekonomisk och hållbar synvinkel. Leverantörsbasen och eventuella fördelar med att använda lokala leverantörer utreds om det finns förbättringar som skulle kunna göras för att minska kostnader i transport och på samma gång koldioxidutsläpp.

Metoden i detta examensarbete är genomförd utifrån teorier från leverantörsledning och hållbara leverantörskedjor för att göra Vestas leverantörskedjor så effektiva som möjligt för att minska kostnader och utsläpp. Leverantörsbasutvärdering och leverantörsutvärdering gjordes för att hitta de mest lämpliga leverantörerna antingen från redan registrerade leverantörer eller tillgängliga på den finska marknaden.

Resultatet visar att det finns betydande kostnads- och utsläppsfördelar med att använda lokala leverantörer för de produktkategorier som ingår i forskningens omfattning. Ytterligare utveckling av leverantörsbasen behövs för att utnyttja alla tillgängliga fördelar med att använda lokala leverantörer.

Språk: Engelska Nyckelord: Leverantörsbas, Leverantörsutvärdering, Hållbar leverantörskedja, Inköp

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1 INTRODUCTION

In order to stay competitive today in the wind turbine manufacturing and installation market companies strive to maximize value of every euro spent. In order to do this an effective way is to look supply chain and to optimize the sourcing and purchasing activities done for projects and reduce and money wasted on non-value adding activities. This thesis will investigate the potential transport cost saving and reduced emissions of using local suppliers in Finland for the construction phase of wind parks. The thesis is done in cooperation with Vestas Wind Systems A/S and the Onshore construction department in North-Central-Europe (NCE) area and specifically focused on the growing wind energy market in Finland. For the theoretical framework supply chain management, sustainable supply chain management, and supplier evaluation are chosen and the method in the research is supported on the relevant theories of choosing the most suitable suppliers for the construction of wind parks in Finland. Part of the thesis will focus on the potential emissions benefits of choosing local suppliers could bring. The method chapter will be going through how the research was conducted based on the theoretical framework laid out. In the result chapter the findings of the research will be presented and analysed.

1.1 Background of the Problem

Wind turbine construction projects in Finland are many times using the same suppliers as in the rest of the Nordic countries where many wind park projects have been executed in the past 10 years and there is an established way of working and working supply chains. For Vestas the Finnish market has grown with 76%, from 126MW delivered to 222MW just from 2019 to 2020 and has the same strong market is showing for 2021 (Vestas Wind Systems A/S, 2021). This large increase in sales shows a greater need of demand and flexibility to come from the supply chain to support the Finnish construction projects. With a growing market and activities in Finland a lot of material and services are still sourced from suppler located abroad even if there could be possible suppliers domestically with necessary capabilities even already registered as vendors with Vestas. Importation leads to higher transportation costs and longer lead times for which is unnecessary and can cause

issues with deliveries to projects. It also increases the carbon emissions caused by transporting material and workers from abroad either by trucks, ships or airfreight.

The transport costs are already taken into consideration when making the sales budget for the sales tender as this affects to price towards the customers and decisions makers this is an important aspect to keep trying to improve. Companies need to look at the whole supply chain to try and optimize all activities and reduce spending.

Currently Vestas does not know if the material and services used at the wind turbine construction projects are taken from the most suitable suppliers from an economical and sustainable standpoint. This should be investigated if there are improvements that could be made for the Finnish market specifically.

1.2 Objectives

There are three main research objectives for this thesis.

1. Map out which suppliers we import material or services from for each project executed in Finland in 2020 and 2021. This can be done with using historical purchase data from ERP system.

2. Find out if there are suitable suppliers in registered supplier database or if new suppliers are needed in Finland to lower transportation costs. Together with sourcing department and project team members the most suitable suppliers can be determined.

3. Analyze what the potential cost reduction and decreases in emission emitted by using local suppliers brings to the company. By estimating transportation costs decreases and receiving offers from alternative local suppliers the cost and sustainability benefits can be proved. The sustainability can be measured in CO_2 emission avoided. A measurement Vestas is using to measure their sustainability as well in its yearly report.

This will be of use to the project teams executing wind park projects in Finland to choose a suitable supplier for needed material or service which takes sustainability into account. If there are benefits which are easy to utilize then standard suppliers should be chosen and

the sourcing activities aligned accordingly. The findings will made into a report for Vestas' stakeholders to review and new registered suppliers can be implemented in current preferred supplier documents which are used by project team.

1.3 Delimitation of thesis

For the thesis certain limitations are set. The research will only include wind park construction projects in Finland. The projects included in research only refers to EEQ (Engineering and equipment delivery) projects and does not take into account EPC (Engineering, procurement and construction) projects as the scope delivered in these are different. The orders and material which are rented or purchased for the construction phase don't include the main turbine components (towers, nacelle, blades, hub) as these are sourced internally within Vestas and belong to different supply chain. The material and services sourced for the construction of wind power projects included in the research are site installation material and some accessories for wind turbines which are commonly used at all wind turbine construction projects and needed to complete construction. These order fall into the scope of procurement for the Project team at Vestas. The material and services are categorized in the result chapter.

Projects executed in 2020 and 2021 are chosen in the data gathering part of the research as they have been built and handed over to customers, have the most recent data and include enough projects to make feasible decisions in case new supplier deemed to be needed or if there are sufficient suppliers for the different material and service categories.

The sustainability review of the orders will only concentrate of the economic and environmental aspect of transporting and delivering goods or mobilizing workers to the construction sites. The sustainability review will not consider the social factors of supplier selection or environmental factors in other parts in values chain than transportation from suppliers to the project construction sites.

2 The Company

In this chapter Vestas Wind Systems A/S will be presented to give more clarity in the operations of the company and what its main activities are. This is a company that started of a small family business is now the world's largest manufacturer of wind onshore and offshore wind turbines.

The history of Vestas Wind Systems A/S starts of in 1898 in the city of Lem in Denmark Vestas gets its current name in 1945 when Peder Hansen established VEstjysk STaalteknik A/S, but the name proves to be too difficult to use daily, so it is shortened to Vestas and with this they start manufacturing household appliances such as mixers and kitchen scales. It's however in 1971 when the company develops a technology that turns wind into electricity and with the coming oil crisis this was a new start for the company. In 1979 Vestas supplies the first functioning wind turbines with a rotor diameter of 10 m and a capacity of 30 kW. With this important first sold turbine the development of larger and more effective wind turbines starts and the business model the company has today is introduced (Vestas Wind Systems A/S, 2021).

Vestas Wind Systems A/S has its head office still in Denmark and the city of Aarhus and is today a global leader in sustainable energy solutions and core business is designing, manufacturing, installing, developing, and servicing wind energy and hybrid projects all over the world. The company has around 29 000 employees globally and has installed over 145GW of wind turbines in 85 countries which has prevented 1,5 billion tonnes of CO_2 being emitted into the atmosphere and contributed to a more sustainable energy system (Vestas Wind Systems A/S, 2021).

Vestas is divided in 2 major departments: Power Solutions and Services. The Offshore department was merged into the Power Solutions department in 2021 forming the new Power Solutions which handles the wind turbine projects and installations constructed both on land and at sea. The Onshore department stood for 15B€ of order intake in 2020 compared to Offshore with 4B€ order intake showing that the onshore wind market still is much larger than offshore. In 2021 the order intake for the new department was 18,1B€. The organisation is still somewhat split into the two market segments internally as the technology, projects setup and construction methods vary from onshore to offshore. For

both On- and Offshore the turbines types used share the same design principles and main component set up but as there are different requirement same turbines models can't be used in both locations. The revenue in 2021 totalled to 13,103M€ keeping the same level as in 2020 much of the help of the Offshore department inclusion to Power Solutions. The EBIT margin falling to 1,5% is primarily attributed by the instability is supply chain, accelerating costs and inflation which the whole wind market suffers from today (Vestas Wind Systems A/S, 2021).

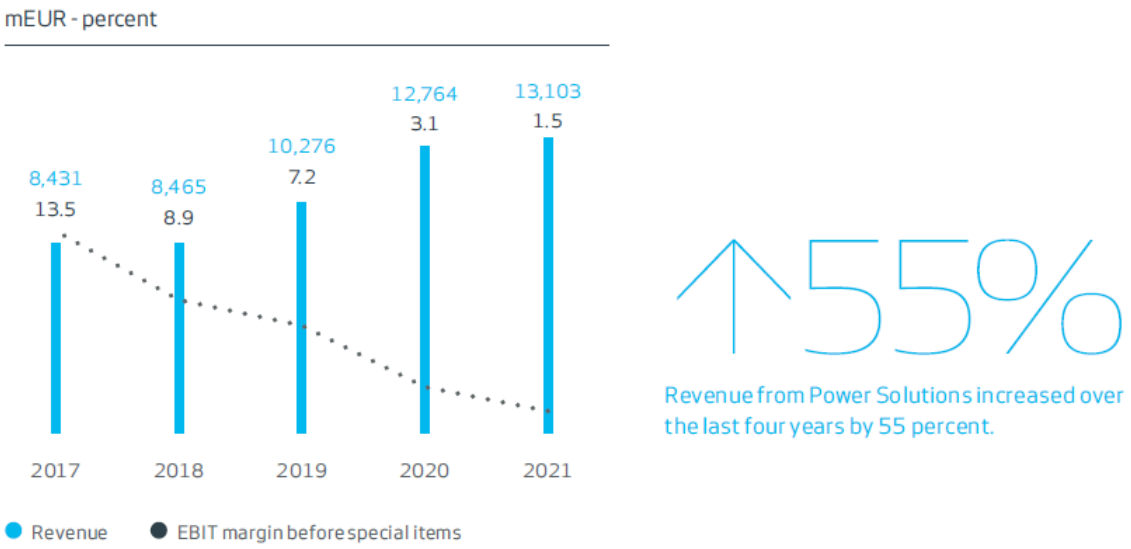

Figure 1. Power Solutions revenue and EBIT before special items (Vestas Wind Systems A/S, 2021).

Vestas' Service business takes over as the wind turbines are ready constructed and the maintenance period begins. The Service department monitors the energy production capacity and conditions of all turbines installed and manages planned maintenance plans and needed services as agreed with the wind turbine owners. Its order intake in 2021 was 29,2B€ (Vestas Wind Systems A/S, 2021).

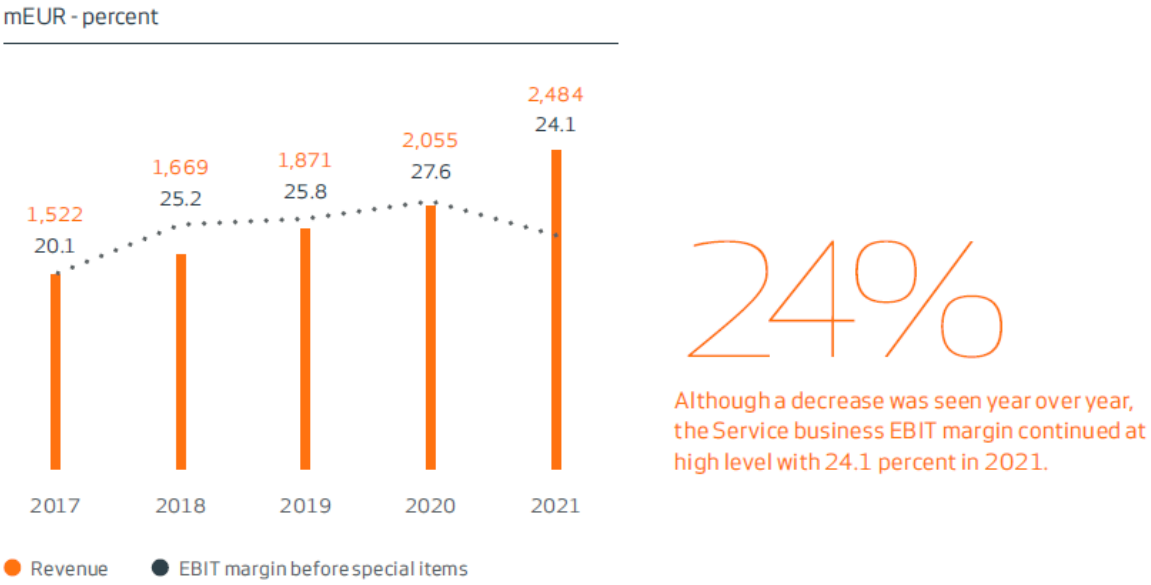

Figure 2. Service revenue and EBIT before special items (Vestas Wind Systems A/S, 2021).

Within Vestas main department there are also regions which manage each of the main departments with own organizations. Europe, Middle East, and Africa (EMEA), Americas and Asia Pacific are the regions, the sizes of the regions vary a bit which is seen in the regional distribution of revenue in figure 3. Focusing on Europe, Middle East, and Africa region we can see that Finland is top 2 market for Vestas in the region when it comes to deliveries which means installed capacity of 838 MW. The region is also performing well and has increased its order intake consistently since 2017.

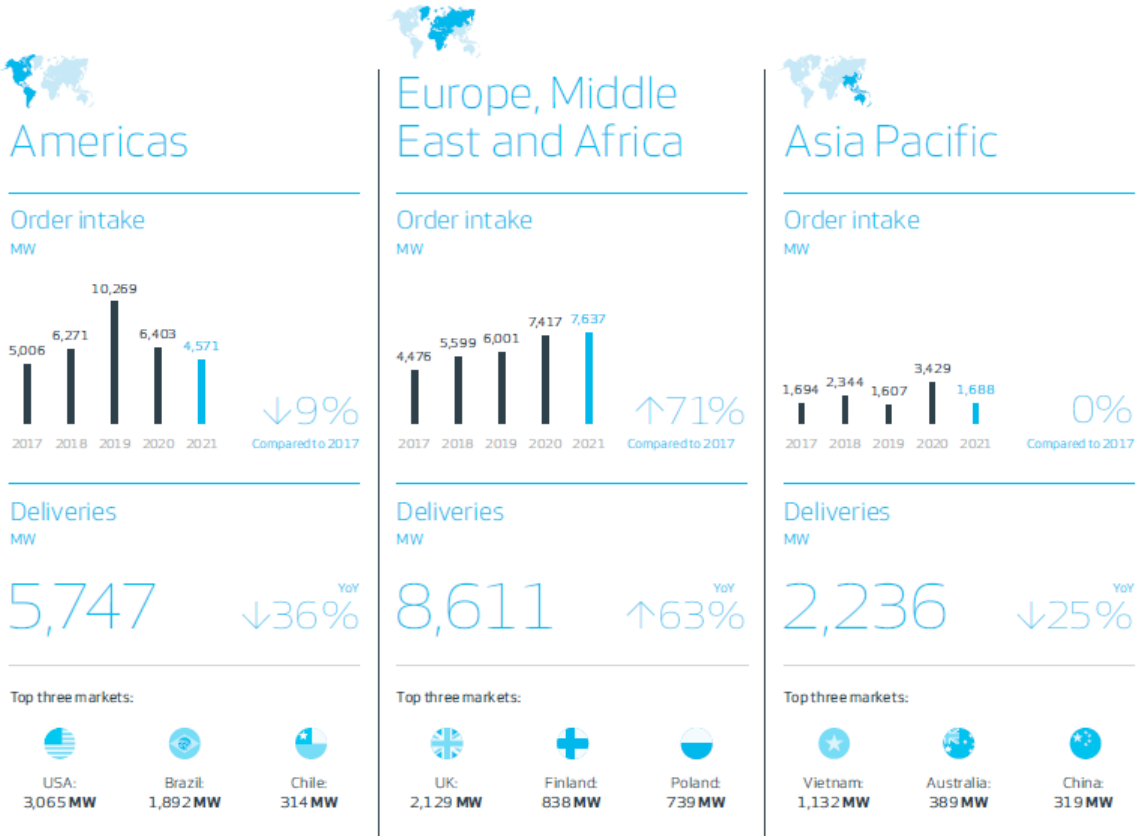

Figure 3. Regional distribution of revenue within Vestas (Vestas Wind Systems A/S, 2021).

This thesis is done in cooperation with the construction department for Vestas Power Solutions and onshore wind turbine projects in Europe, Middle East, and Africa region. This department consist today of about 5000 employees located in the countries as marked in figure 4.

Figure 4. Vestas regional split for the company (Vestas Wind Systems A/S, 2021).

The NCE region is even split into regional departments where Finland is grouped with Denmark, Iceland, Norway and Estonia. The construction department of EMEA handles the delivery of new wind turbine projects which 2020 accounted for 5289 MW and 30% of the total installed MW for Vestas. Vestas Finland Oy is registered subsidiary to Vestas Wind Systems A/S and in 2021 it installed turbines with 838 MW of capacity in Finland and similar figure will be installed in 2022. The Finnish market is currently very strong for Vestas holding about 50% of the yearly sales. Vestas Finland Oy consists mostly of personnel working in the Service Business to maintain installed turbines but has from 2021 hired workers to the construction department specifically for managing new built projects in Finland.

For new built wind park projects to be done successfully there is a project team and support functions assigned to each project handed over from the sales team which takes over when a sales contract has been signed between Vestas and a customer. From here on the project team is responsible for the planning, purchasing of parts and services, construction and installation of the turbines which depending on number of turbines of the wind park takes 12 months of planning and procurement and about 6 months of installation and testing to complete. The projects team's responsibility is to deliver the wind turbines according to agreed scope, budget and timeframe with the client. The major hurdles for this to be done successfully are shipping of main components from Asia, getting installation resources and

dealing with internal quality issues which extends installation time on the construction site and adds cost. The project team needs to actively monitor and look for alternatives to mitigate and deviation from the planned project execution and this requires a lot of communication with internal and external stakeholders.

The turbine is consisting of the main components (tower, nacelle, hub and blades) which often are manufactured in China, Taiwan, Spain, Germany or Denmark. These main components are shipped to ports in Finland and with specialized transport trailers trucked to the project sites. After the wind turbines are erected with a large crane and installation team they are commissioned and tested by a Vestas commissioning team and put on the national grid to produce power for the client. After successful integration to power grid the wind turbine park project is handed over to the customer and hopefully together with the Vestas Service department take over the responsibility for maintaining and servicing the customer's turbines if a Service agreement has been signed. Then the intention is to have the wind turbines be in production for 25-30 years with very low maintenance and running costs compared to fossil fuel power plants. After the production lifetime the wind park owner can either decide to renew the turbines with larger and more effective models, continue running the turbines as installed or decommission the park. As the wind turbine market in Finland is still quite in an early stage with most of the turbines still having more than 10-year production time to go there is no trend showing what the most common use of decommissioned wind parks will be.

3 THEORETICAL FRAMEWORK

In this chapter the theories supporting the research will be presented and the way they are implemented in the research explained briefly in the end of each chapter. The main theories used in the thesis work are Supply Chain Management, Sustainable Supply Chain Management, Sourcing and Procurement and Supplier Evaluation theory. In the following chapters these different subjects will be presented in detail related to be thesis. All of them will support the research as Supply Chain Management is a broad spectrum of activities and governs much of the strategy of a business and how the value chain is functioning. The sustainability aspect is a great interest for Vestas and will support the best practice in Supply Chain Management as it has become increasingly important. Sourcing and procurement theory is basis of purchasing activities and sets the strategy of a company's purchasing department. Lastly Supplier Evaluation is of great importance when looking at current and potential suppliers for a company before putting too much resources onto a partnership.

3.1 Supply Chain Management

The concept of Supply Chain and Supply Chain Management has been evolving since it was introduced as its own area of business. Companies only started to exercise strategic logistical planning in the 1950s. However already in the 18th century the French navy practiced ship building that still are the root of the concept for Supply Chain Management as they carefully planned which trees to use for construction of ships, built canals for supply delivery and standardized ships (Morana, 2013). Supply Chain Management originally started as tactical element in distribution and logistics of goods in a company. Today however it is it has grown and is an inclusive and broad competitive business strategy (Prater & Whitehead, 2012). With globalization and an increasing competition many companies have begun to examine their logistics operations and trying to make it more efficient and eliminate any non-value adding activities. From the 1980s the logistics has started to move away from operations-oriented view towards a strategic-oriented logistic view but in common practice this is called supply chain management (Morana, 2013).

A Supply Chain can be defined as the sum of a company's customer relationships, ordering process, supplier relationships, and the interconnected network of the suppliers' services, material and information (Robert P. Sroufe, 2017). Rather than being comprised of separate activities the Supply Chain are made up of processes which are interconnected to create a complete chain dependable on each other (Monczka, Handfield, Giunipero, & Patterson, 2015).

A Supply Chain starts with resources, often raw materials, and through a number of value-adding activities it ends up at the end consumer. Recently it has also been highlighted that the Reverse Supply Chain is of importance when the goal is to quickly identify and return faulty or damaged products back through the supply chain (Monczka, Handfield, Giunipero, & Patterson, 2015). The connections in the supply chain should all contribute to add value to each following step in the chain and fulfill its purpose. Any connection that does not does this properly reduces the overall effectiveness of the whole Supply Chain (Janvier-James, 2012).

Each Supply Chain has their own conflicting needs as fast response time in demand and high on-time deliveries might result in large inventory, but this causes capital to be tied up. Depending on markets the challenges might be different, but the basic patterns are the same and can be grouped in five areas: Production, Inventory, Location, Transportation and Information (Hugos, 2018).

Production should respond to the what the market is asking demanding, what to produce, how much and by when, are the keys to keep track of and forecast if possible. All this feeds the production planning activities of factories and retailers that are in the beginning of the supply chain. Inventory can be planned at different stages in a supply chain and at each stage the inventory size needs to be considered. The goal of inventory management is to carry the right amount of material so that neither shortage nor overstocking occurs (Prater & Whitehead, 2012).

Inventory can be held as raw material, semi-finished or finished goods but its main purpose is to act as a buffer against uncertainty in the supply chain as there might occur disruptions in lead time in production and transportation of material. The negative aspect however is that it can be expensive with inventory if it is not properly managed. To manage it well the

company needs accurate forecasts of future demand and timely replenishments of material into stock (Hugos, 2018).

Location of storage facilities or production plants affect the prices of the products and transportation costs as well as flexibility and lead time. The location of vendors in the supply chain and the cost of transporting supplies can significantly influence location decision of a production facility or warehouse that hold the inventory. As an example, can high costs of transporting large volume of low-value goods or a high consumption of energy attract production plants be located close to the supply sources or consumers (Quayle, 2006).

Transportation in between the supply chain locations have several alternatives: trucks, railroad, airfreight, sea freight. Truck deliveries are generally reliable and fast but has limitation ins wight and size. These are better for smaller and fewer goods (Hugos, 2018). They provide a low damage and loss rate and as there are many companies providing this service it drives cost down. Some issues can be caused by weather conditions and traffic congestions. Railroads provide low costs for carload size lots and containers. It requires the goods and material to be packed so it can withstand rough handling. The lead time with railroad can be inflexible as it follows specific timetables (Prater & Whitehead, 2012). Airfreight is the method that the shortest lad time but at the highest cost. This makes it most suitable for high value, urgent fragile goods. It can reduce inventory with the short lead time and safe handling, and it is becoming a more important means of transport. Shipping by sea is an alternative to airfreight if goods need to be transported overseas. It can handle more bulk, low cost and raw material than the other means of transportation. With the large ports, containerization (the process of combining many loads into one protected shipping container) and globalization sea freight has become a reliable alternative for goods that don’t require short transportation time (Hugos, 2018).

The latest thing to consider is *information*. The Supply Chain acts as a medium for the exchange of information and the communication of orders or directives between parties (Quayle, 2006). There is plenty of data to collect from each step in the Supply Chain, but only timely and accurate information can improve coordination and decision making. Today there are many ways to collect the data and measure it from the own activities, but it is as

important to have transparent information with close partners in the supply chain (Hugos, 2018).

The supply chain at wind park projects is following very much the just in time method as there is a limited storage area for the components and a limited time when it's optimal to receive the parts to minimize wasted time and in other words money. For the thesis the writer has chosen to look more closely into the location and transportation of the five main areas of Supply Chain Management when this has the most impact when looking at alternative suppliers more suitable for the Finnish projects. The Supply Chain Management have become even more a challenge during the Covid-19 pandemic period disruptions, sudden price increases and longer delivery times which have proved to become more and more common. The need for strong and reliable suppliers so very important but also their costs are increasing meaning that Vestas can't expect them to keep the same price levels.

3.2 Sustainable Supply Chain Management

In this chapter Sustainable Supply Chain Management will be covered and how it can be of importance for the case company. For this thesis focus is partly on the reduction of unnecessary transportation of material or travelling distances for service workers to the project sites. This would directly decrease the CO_2 emissions emitted by the different modes of transportation used by the suppliers. Vestas has by 2022 introduced a Key Performance Index on lowering the CO_2 emitted and measuring the CO_2 avoided which is compared to the average carbon footprint of the electricity produced. The sustainability report from 2021 also stated that a key focus by Vestas is to increase its sustainability in the supply chain and have this in the most crucial category to improve (Vestas Wind Systems A/S, 2022).

As Sustainable Supply Chain Management covers both operational drivers of economical profitability, the relationship to people and the environment, it gives the profound opportunity to impact our society (Kneymeyer & Winter, 2013). Sustainable Supply Chain Management is an important factor of sustainable development in which the environmental and social aspects need to be met by supply chain parties to remain within the supply chain. It Is still expected that competitiveness is to be maintained through meeting customer needs and related economic criteria (Taticchi, Tonelli, & Pasqualino,

2013). It should be noted that Sustainable Supply Chain Management is part of Sustainable Development but in the thesis the focus will be on the Sustainable Supply Chain Management itself.

Sustainable Supply Chain Management includes the management of material, information and capital as well as cooperation between companies within the same supply chain keeping in mind all three factors of sustainable development: economic, environmental and social (Morana, 2013). These three pillars of sustainability should be given the same amount of consideration according to the triple bottom line approach (Beske & Seuring, 2014). The success and competitiveness of a company is the basis of the economic performance in contrast to the social and environmental factors. The economic factor is quantitative in its nature and is focusing on the efficient use of resources and achieving a return on investment in long-term. The environmental factor includes objectives, plans and mechanisms that focus on greater environmental responsibility and the development and introduction of environmentally friendly technologies. The social factor has two sides as it refers both to individuals and organizational levels. While actual material conditions are the basis of the social dimension, the social factors themselves are immaterial and therefore difficult to analyze. Emphasis on the social aspect of sustainable supply chain is emerging the most complex challenge in sustainable supply chains due to the fact that it involves a wide range of stakeholders with different goals, demands, and opinions that may interpret the same situation differently (Kneymeyer & Winter, 2013).

The importance for Sustainable Supply Chain Management has become greater over the last years as there is pressure from different stakeholders of it being implemented in a company. The requirements come from different stakeholder such as governmental which enforces laws, norms and standards towards sustainability, environmental with focus on pollution, use of fossil fuels and minerals, and social pressure in form of reputation and image (Morana, 2013).

Early studies in Sustainable Supply Chain Management focuses on the environmental green supply chain issues and their performance impact, which is called the Green Supply Chain Management. This approach of Green Supply Chain Management focuses on the economic benefits of environmental management practices through implementing environmental policies like environmental purchasing policy, environmental reports policy, reducing use

of unsustainable products, and diminishing use of fossil fuels (Andalib & Soltanmohammadi, 2018).

There are 3 main strategies within Sustainable Supply Chain Management efficiency, consistency and sufficiency. The first is guided by the approach to generate economic value with lower negative social and environmental impacts and thus to minimize waste and use less resources in each step of the supply chain and throughout the entire supply chain. The second, consistency approach, aims to replace unsustainable materials with materials found in natural ecosystems. Comparable to efficiency this does not focus on reducing material consumption an instead replace all unsustainable material and energy flows of the whole supply chain with environmentally friendly alternatives. The sufficiency approach focusses on the fact that every product which does not have to be produced should be eliminated and with it the harmful impacts. Less consumption and production and the substitution of products with services are guiding principles of sufficiency (Schaltegger & Burritt, 2014). All of the three mentioned strategies can and is often used at once. The efficiency is the strategic approach which will be taken into use in this thesis as there are aspects of all three strategies in the options suggested to be taken into use by Vestas.

To support decisions in a company there need to be measurable qualities of sustainability that can be reviewed and optimally improved on. The main priority of a corporate sustainability-oriented performance system is to measure, communicate and reduce the absolute amount of negative environmental and social impacts substantially and to contribute to a sustainability transformation of markets and society. This includes consideration of sustainability risks and opportunities of the existing supply (Schaltegger & Burritt, 2014). The performance measurement and management system of sustainability in supply chains is a balanced and dynamic system that facilitates support of the decision-making processes by gathering, elaborating and analyzing information (Taticchi, Tonelli, & Pasqualino, 2013). As sustainability in supply chains looks to improve environmental and social performance of companies it addresses the challenges of sustainability risks, opportunities and trade-offs from a companies and value chain perspective it can be seen that sustainability should be integral to management of supply chains. Sustainability performance management would at the same time be a vital part of performance management but has received little research attention (Schaltegger & Burritt, 2014). Going from managing unsustainable supply chains towards a more sustainable with a focus on

the removal of harm, trade-offs between all aspects of sustainable performance, great innovations in terms of practice which separate the social and environmental from economic and can improve measurement of social and environmental performance (Taticchi, Tonelli, & Pasqualino, 2013).

This thesis will focus on risk- and opportunity-oriented strategy of Sustainable Supply Chain Management and how it's utilized. There are two major supply chain management strategies *"(1) risk and (2) opportunities, which are influenced by different intentions (assess and reduce risks vs increase and realize opportunities)"* (Schaltegger & Burritt, 2014). They differentiate as the first is aiming at reducing or eliminating issues in production or connected to suppliers as the other aims a realize solution driven by sustainability aspects, one more positive than the other. For sustainability performance of supply chains, the split in perspectives is more complicated when considering the variety of measurement scales which can all be applied to both perspectives (Taticchi, Tonelli, & Pasqualino, 2013).

Different levels of measurement provide different levels of precision in the end result (Schaltegger & Burritt, 2014). Sustainability measurements identifies and uses different scales depending on the required level of accuracy for making the company's progress against environmental, social and economic goals transparent. A performance measurement focused on the environmental factor of sustainable supply chain is the carbon footprint which is caused by production or the transportation of goods and services. In risk-oriented Sustainable Supply Management pollution seen as a risk if it exceeds certain absolute or relative levels or if there are comparable options that can be used (Beske & Seuring, 2014). Opportunities in sustainable supply chains refer to existing sustainability problems and to how solve these and what the most sustainable products or services look like. Managing sustainable oriented opportunities can be based on the search for innovations relating to what could be improved and should be done. For example, in supplier product development to find more environmentally friendly solutions in manufacturing or by using a reusable material (Schaltegger & Burritt, 2014). Carbon reduction targets by governments has put pressure on companies to implement decarbonization strategies across their departments and this has caused companies to analyze their carbon emissions and explore options for reducing them (McKinnon & Piecyk, 2010).

Examples of the relative performance measures of environmental efficiency in a supply chain are the ratios provided by the carbon footprint of a product or service. Depending on the product or service this can be measured in CO_2 /unit or CO_2 /ton/km and so on but highlighting the footprint in CO_2 is key. This approach of measurement can be utilized when measuring the potential benefits Vestas would have in utilizing local supplier options as different services and material supply chains would perhaps cause less emissions (Schaltegger & Burritt, 2014). To calculate the CO_2 emission in the most accurate way one would use the energy-based approach where the amount of fuel is compared to the weight of material being transported with different means of transport. This data is often registered with the transport companies but not made public as it can be business sensitive. The activity-based approach can used be due to absence of specific energy data be used to make an estimate of the carbon footprint of a transport operation by using the formula:

CO_2 = tons transported x distance travelled x g CO_2 emissions factor per ton-km

The recommended average emission factors per transport mode have been calculated by Alan McKinnon and Maja Piecyk in their report *Measuring and Managing CO_2 Emissions of European Chemical Transport* and can be seen in table 1.

Table 1. Average emission factor per transport mode (McKinnon & Piecyk, 2010).

Transport mode	**gCO_2 / ton-km**
Road transport	62
Rail transport	22
Barge transport	31
Short sea	16
Intermodal road / rail	26
Intermodal road / barge	34
Intermodal road / short sea	21
Pipelines	5
Deep-sea container	8
Deep-sea tanker	5
Airfreight	602

In theory there are several ways in measuring the emission from transported goods and as this is part of the objective for the thesis the activity-based approach will work well.

Sustainable Supply Chain Management is not only challenging because of complex international relationships of goods and services and long geographical distances between

a large number of suppliers but also faces cultural and political differences in supplier countries and internally in the company. For this thesis the focus will be on the ecological part of the sustainability in supply chain and will highlight a new aspect for Vestas as this is not currently a measurement of supplier evaluation process. The carbon emissions during transportation will be calculated based on the transportation mode and distances the material or personnel to perform services need to cover to the different construction sites in Finland.

3.3 Sourcing and Purchasing

In supply chain management sourcing and purchasing are two very important activities. Sourcing is the activity of identifying the source of the material and establishing a secure supply. The material itself can have various forms such as raw materials for production process, accessories for production or ready products that are to be sold further to end consumer or other services (Monczka, Handfield, Giunipero, & Patterson, 2015). The purchasing part is then initiated when the source is located and negotiations, contracting and ordering is needed (Dani, 2020).

For sourcing a department forming a strategy which conforms with the company's overall strategy is key to make sure that the day-to-day work is also helping the company fulfilling its objectives. While a company might have purchasing strategies at the function level, it is crucial to successfully manage many of products and services that they purchase by formulating and implementing different purchasing strategies for each so-called purchase category (Ates, 2014). Supply management must combine each objective with a specific goal that it can measure and work with. These specific goals are the initial step for a detailed commodity strategy formulation process. The objectives drive goals at the highest levels of an organization and at the functional or department level. Examples of company supply management goals associated with various supply management objectives can be cost reduction, technology development or supplier base reduction. Each of the company strategies/goals will affects what the sourcing strategy will be and thus day-to-day work for purchasers (Monczka, Handfield, Giunipero, & Patterson, 2015).

Purchasing is a functional group and activity performed often by a department in a company with the goal to deliver maximum value to the company. The purchasing

department performs such activities as supplier identification and selection, buying, negotiating agreements, contracting, supply market research, supplier review and development and purchasing system development (Monczka, Handfield, Giunipero, & Patterson, 2015). The objectives for purchasing can simply be defined as getting the right goods, at the right time, in the right quantity, from the right source for the right price (Bannister, 2003). This is very relevant also for wind park construction projects as there is a limited time window when all resources need to be in place for erection of the wind turbines themselves to get started.

One of the most crucial objectives of the purchasing department is the selection, development, and maintenance of suppliers and the supply base. Purchasing must keep up to date of current conditions in supply markets to ensure that purchasing first of all selects suppliers that are competitive and secondly recognises new suppliers that have the potential for outstanding performance and develops a closer relationship with these suppliers. Purchasing department needs also to improve existing suppliers and develop new suppliers that are not competitive. In so doing, purchasing can select and manage a supply base capable of providing performance advantages in product cost, quality, technology, delivery and product development (Monczka, Handfield, Giunipero, & Patterson, 2015). Especially the points of selecting suppliers, developing new and existing suppliers are at great use for this thesis and will be further developed in the chapter 3.4 Supplier evaluation and development. The purchasing strategy for Vestas is briefly explained in the chapter 5.

By using Purchase Category Management or also called Portfolio Management, a purchasing team will be able to focus on determined material and services to maximise value for the company. A category in purchasing can be defined as “a similar set of products and services that are purchased from the same supplier or have similar product and spend features (Ates, 2014). The team is often composed of personnel from the operational group, product design, process engineering, marketing, finance, and supply management. With having a broad knowledge base in the team different viewpoints can be considered when dealing with the sourcing material and services. In general, the more important the commodity is the more likely that cross-functional members and user groups will be involved to ensure the most suitable purchase is made (Monczka, Handfield, Giunipero, & Patterson, 2015). A company can have many different types of procurement activities from

commonly used office supplies to critical raw materials in production and services and thus the competitive priorities and strategies differentiate across purchase categories. While a company can focus on cost reduction objectives for purchasing office supplies or raw materials with a low supply risk it might need to pursue joint innovations with suppliers for components with high profit impact for their end customers. Purchase Category Management is a common practice among many mid- and large-size companies in different fields and its importance is shown to grow. (Ates, 2014). The process of a sourcing strategy deployment begins at the product category level and with the following steps.

1. Internal need evaluation: this first step should give a baseline for the strategic category management and provide an insight of sub-categories, major suppliers, key requirements & stakeholders, internal controls/policies currently in place, and a brief category history and some of the challenges & successes it experienced (Romney, 2020).

2. Spend Analysis: the foundation of any category management strategy depends on a solid understanding of the historical and ideally forecasted spending. Without accurate details it will be hard to imagine how the company can formulate any worthwhile strategy. That what can be measured can be improved. There are a several different ways to dissect data and as a minimum it should split in category, supplier, location, and business department (Romney, 2020). For the Spend Analysis the Pareto principle is a common method for visualize the spend characteristics of purchases in Supply chain Management. According to the Pareto principle, also known as the 80/20 rule, 80% of the outcomes are decided by 20% of the activities or factors. For example, 80% of the total profit is generated by 20% of the product categories, or 80% of the maintenance expenses are due to 20% of the equipment. This rule is observed in most of the situations or conditions and thus this is a widely used principle in many of the areas including inventory management, finance and project planning etc (Brock, 2022). A common way to visualize this in through the Pareto diagram, see figure 6.

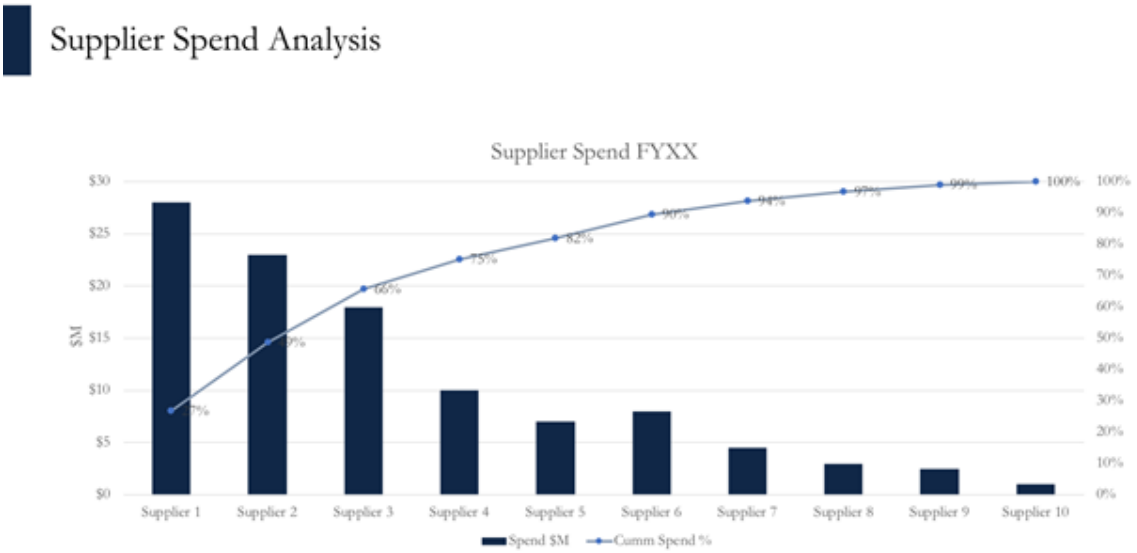

Figure 5. Pareto diagram showing spending level per supplier (Romney, 2020)

3. Supply Market Analysis: understanding of the supply base market is key to developing a category management strategy. Begin by gathering market intelligence and benchmarking information via a number of places and sources. Commonly used market analysis tools are the Porter's 5 Forces model. Porter's 5 Forces model is more useful when entering a specific sourcing event or deal negotiation as it will help analyse the level of competition that exists at a specific point in time (Romney, 2020).

4. Category Segmentation: segmentation modelling effectively applies the appropriate strategic category management for the material or services you are sourcing and should help prioritise where resources are spent. The Kraljic matrix, in figure 6, developed by Peter Kraljic (Romney, 2020). In sourcing the Kraljic matrix is used to classify the products or services a company purchases according to its profit impact and its supply risk and criticality for the operations (Cordón, Hald, & Seifert, 2012). The products can be classified as low criticality and low profit impact, and these should be made a routine purchase without spending too much time and effort on. If products have a high profit impact and low supply risk it should be bought at competitive cost, here scale of economy often come into play. When the product has a low impact on profitability and high critical impact the product is a bottleneck item it's crucial to avoid any issue in supply chain and sourcing. If a product has both a high profit and critical impact, then those are classified as

strategic items and it's important to seek out long term contracts and cooperation with suppliers to secure these for the future needs (Cordón, Hald, & Seifert, 2012).

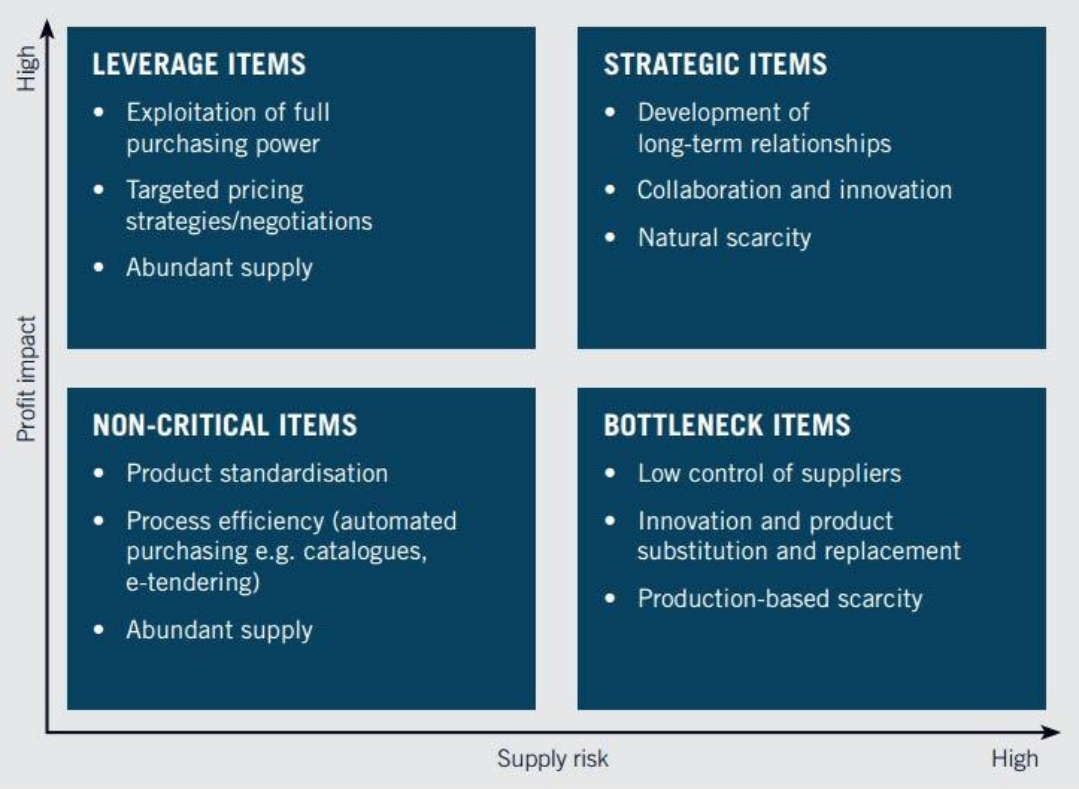

Figure 6. Kraljic matrix (Webb, 2017)

5. Strategy: all the fact-based analysis steps that has been conducted up to this point should highlight and allow to articulate a couple of high-level strategies that will guide all purchasing activities that will occur. It should include goals or KPIs to measure the effectiveness of the implementation (Romney, 2020).

6. Category Plan: with the category management strategy with goals to save millions in spending, a list of initiatives, projects or tactics must be developed that will deliver the results. A Category Plan should call out the name of the project, description of the project or tactic to be used, strategy alignment, value, and timing. A Project Prioritisation Matrix is a useful tool here to help you through this process. Although you may not formally develop criteria to plot your project on the matrix, it's important to think about the Business Value and Ease of Implementation of the initiatives you have listed (Romney, 2020).

For this thesis sourcing and purchasing theory is at the base of the methods as this includes finding the most suitable source for material and services and aligning this with the business objectives for Vestas. In order to review the current situation, the product categorization and spend analysis is key and after this a category strategy can be set. For this thesis research the steps 1-4 as described in the earlier section will be utilized as this will help with meeting the research objectives. In the next chapter supplier evaluation and selection is further presented.

3.4 Supplier Evaluation

Supplier selection for purchasing of material and services if a key element of executing strategic sourcing. The selection or evaluation is a process made to reduce the risks of purchasing and to be able to maximize the overall value for the purchasing party (Monczka, Handfield, Giunipero, & Patterson, 2015). Usually when selecting supplier an evaluation process is done for both complex and expensive purchases as well as long-term agreements to make sure the supplier can meet technical, financial and commercial requirements set out by purchaser (Sollish & Semanik, 2011). The supplier evaluation and selection process consist of 7 different steps as seen in figure 7. Before evaluating the supplier, it's recommended that certain entry requirements are fulfilled by the suppliers such as financial capabilities, business strategy, supportive management, proven references and technical capabilities (Lammi, 2016).

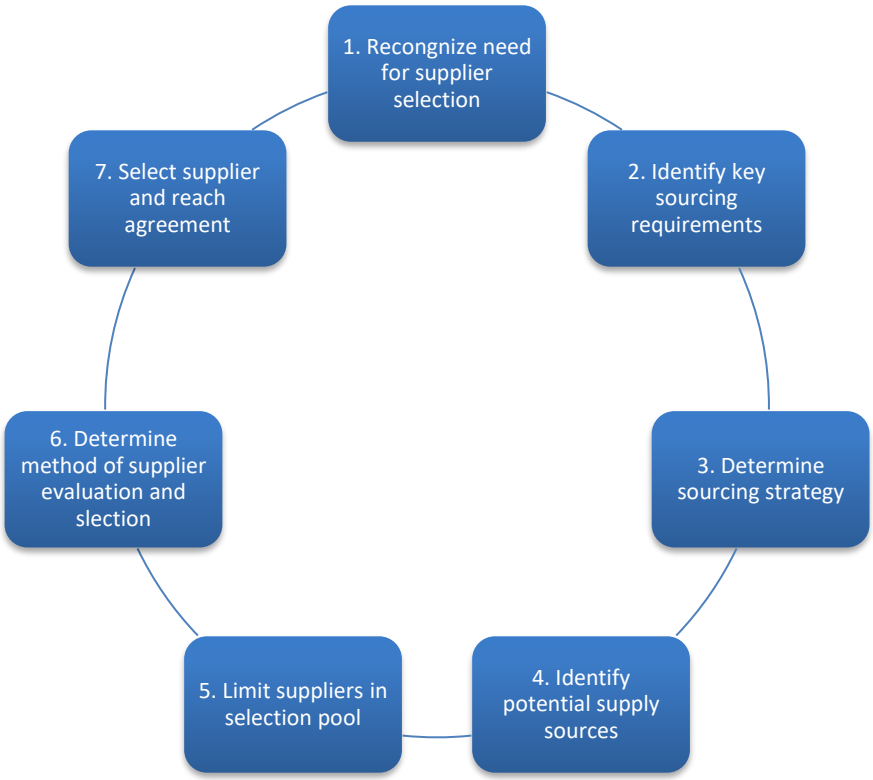

Figure 7. The 7 steps of supplier evaluation and selection process (Lammi, 2016)

This evaluation model is simple to scale to requirements and needs of each supplier selection. The method can be seen as part of Vestas process already as the is a preferred supplier database, financial reviews and agreements in place with certain suppliers. To utilize the information when going through the 7 steps of supplier evaluation and selection process can be of great support.

Category management and developing further insights in stakeholders' requirements and needs to compare those to the supply base capabilities and market in order to align all internal requirements to the market conditions is a key aspect of supplier evaluation. The category manager often has good experience and knowledge of the products and services they are in charge of. The strategy of contract management forms the plan for negotiating agreements, supplier scorecards for monitoring performances and communication strategies for all suppliers present in the products categories (Monczka, Handfield, Giunipero, & Patterson, 2015).

Once the strategy is set the process of evaluating of suppliers begins. The purchasing department need to work together with the stakeholders and include them in the category teams to make sure valuable input is shared and actual need understood which help evaluate and select suppliers. Engineering department is a good example of a supporting

department and can evaluate suppliers' products and process performance capabilities from a technical standpoint. Suppliers often know who the main stakeholders are in supplier evaluation and can communicate directly with Engineering, but it has to in the end be the purchasing department to make commitment and contractual agreements preferably with consensus from all stakeholders (Monczka, Handfield, Giunipero, & Patterson, 2015).

Take into consideration additional decision steps to evaluate strategies and decisions against the three dimensions of sustainability. For supply chain management, performance objectives and measurement are not balanced but usually limited to the economic dimension (Beske & Seuring, 2014) The supplier selection process is often used as a foundation for strategic sourcing. With supplier selection the overall aim is to maximize the value for the purchasing party while to minimize and uncertainty and risk that is connected to the purchase (Lammi, 2016).

Effective supplier management and development starts with determining an optimal number of suppliers that a company should have for a specific product category. Supply base optimization focuses on analysis of the supply base to make sure that only the most capable suppliers are in the supply base. This often involves eliminating suppliers that are unwilling or not capable of achieving supply management performance objectives, either currently or expected in the near future. The elimination of both small-purchase-volume suppliers is usually the first step of the optimization process. It's then followed with the replacement of good performing suppliers with better performing suppliers or initiating supplier development initiatives with existing suppliers to improve their performance. The first phases of supply base optimization and supplier evaluation usually results in an absolute reduction in the total number of suppliers. This is not the end result as each product category need to find its optimal number of suppliers. There can be a reduction of number of suppliers even if efficiency is increased in case a supplier is willing and capable to develop into other product categories and provide more material or services then before (Monczka, Handfield, Giunipero, & Patterson, 2015). For example, if an inspection agency can include more inspection points in their scope of a wind turbine as well as providing services to correct any fault found during inspection instead of again mobilizing a new team of technicians to efficiency has increased even with fewer supplier involved.

By evaluating current supplier and supply base it has been concluded that, if purchasers select suppliers carefully and develop close and collaborative working relationships with few numbers of suppliers, risks in the supply chain can actually decrease. Risk not only include supply disruption but includes poor supplier quality, poor delivery performance, and overpaying for items due to a non-competitive sourcing situation. A company can maintain multiple suppliers for each product category can actually increase the probability and level of risk. Having more suppliers creates the opportunity for increased product variability or inconsistent quality across the supply chain. There is an additional benefit of lower supply base administration cost as less of the purchasers' resources goes on contacting and maintaining small-purchase-volume suppliers but instead focuses on the large-purchase-volume suppliers to strengthen both parties' capabilities (Monczka, Handfield, Giunipero, & Patterson, 2015).

The approach of focusing on the 20% of suppliers receiving the majority of purchase spendings or that minority of suppliers that cause the most quality problems is following the same method as the Pareto principle in chapter 3.3. Purchase spend and supplier quality are two possible criteria used to identify suppliers for elimination from supply base. Companies often use this approach when they aim for rapid reduction in the number of suppliers. A disadvantage to the 20/80 approach is the risk of eliminating otherwise capable suppliers just due to them receiving fewer purchases and this less spending. This approach assumes the best suppliers receive the majority of the purchases, which may not necessarily be true. In addition, the buyer may exclude suppliers with needed capabilities that are not currently utilized. See figure 8 for example how suppliers can be identified as low volume supplier and eliminated, and which are identified as candidates for development.

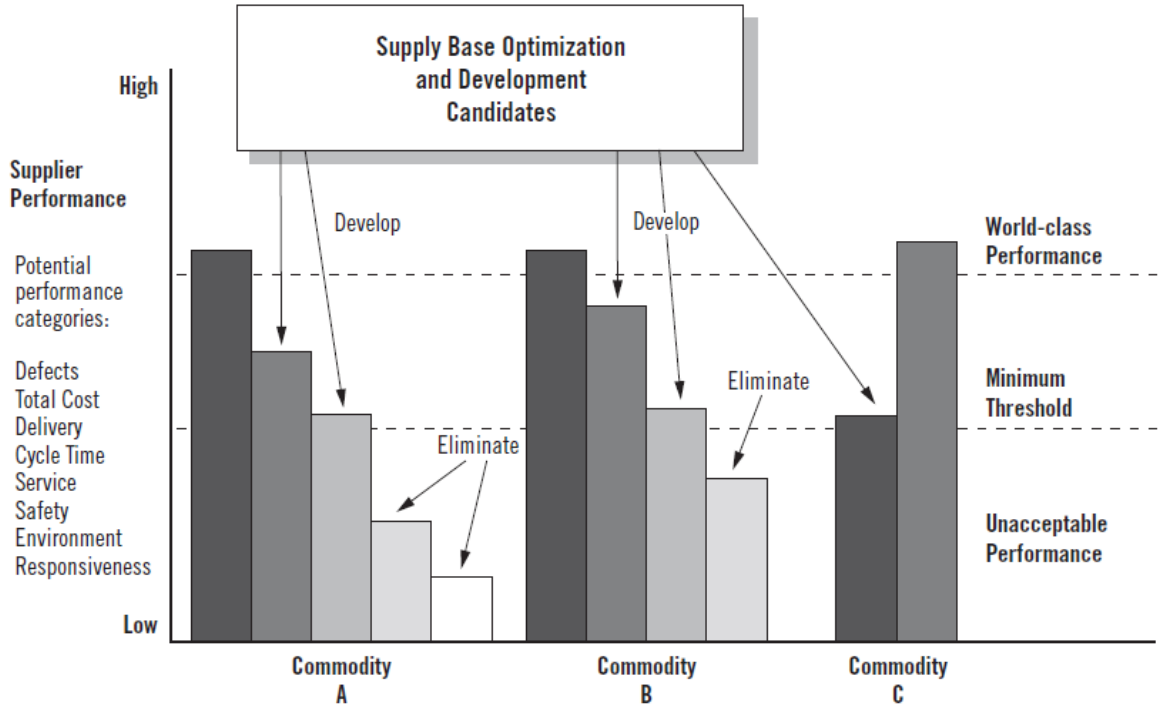

Figure 8. supply base optimization and reduction (Monczka, Handfield, Giunipero, & Patterson, 2015)

There are however risks with using a limited number of suppliers in the supply base. Some companies believe keeping several suppliers for a product category promotes and maintains a good level of competition between suppliers. While other companies might believe that a single supplier can still deliver cost and quality improvements over the life of a contract if a purchaser manages that supplier appropriately. Although most buyers recognize the benefits of supply base optimization, there are still potential risks from relying on a smaller supply base. The first risk is that both parties becoming too dependent on each other. The supplier is dependent for its economic survival, this can happen if a purchaser focuses the total purchase volume for an item to a single supplier. Smaller suppliers with limited capacity can in some cases be forced to eliminate some of their existing customers in order to meet the increased requirements of its larger customer. The result is that the supplier now is dependent on a purchaser for its total order intake financial well-being. Other risks are absence of competition and supplier mandating price levels as their in no alternative for the purchaser. The more difficult and expensive it is to change suppliers, with higher switching costs, the more likely this scenario is. Supply disruption is a real risk when purchasing from a single-location supplier. In case there are local issues at production facility this send ripple affect very quickly is a small supply base set-up (Monczka, Handfield, Giunipero, & Patterson, 2015). This have been very noticeable

during the covid-19 pandemic as transport and travel and disruptions were common and companies faces heavy delays in the supply chains.

By discussing with the purchasing department and stakeholders at Vestas the writer found new insights at how the suppliers were evaluated and considered beneficial to develop. Vestas own purchasing strategy is to limit the numbers of suppliers but as stated there are also risks in getting too dependent on certain suppliers or suffering from disruptions in supply chain. Taking into the consideration that the increasing number of projects in the Finland there is a real risk of disruption if suppliers are not able to keep up with demand and material being late or quality suffering. The risk management with contacting and using of new suppliers need to be considered and current category suppliers be evaluated. This is not an easy task as new suppliers might have limited references and experience in the wind park construction market and the Vestas current strategy of limiting the number of active suppliers makes it even more important to have a proper business case if suppliers are needed.

4 METHOD

In this chapter the method of conducting the research for the thesis is presented and how it's connected to the theoretical framework explained. The methods used in the thesis were selected based on the theoretical framework which best suited the problem and objectives of the thesis. The method chapter first starts with describing the selection of projects included in the research based on the scope and how data collection from purchase orders of these projects was retrieved. With the data collection category segmentation of orders could be done and based on this a spend analysis to review the imported order cost and transport cost. Then supplier evaluation of the product categories was done together with the purchasing team at Vestas and once new alternatives had been found a comparison in cost and sustainability could be done. During the research continuous discussions with internal and external stakeholders were held to get required information.

4.1 Selecting Projects for Data Collection

In order to map out which suppliers Vestas imported material or services from for each project executed in Finland in 2020 and 2021 first the projects included in this scope had to be defined. The data collected for the thesis is taken from eleven different onshore wind turbine construction projects executed in 2020 – 2021 in Finland. It was determined together with supervisor from Vestas that before 2020 there had been few projects executed and the project teams had looked different before this making the purchasing setup a different and not easily comparable to projects executed from 2020 onwards.

With recent increases in raw material and pandemic situation projects executed in 2020 – 2021 will give the most accurate data to base business decisions on as there is no expectation in material prices going down in the years to come. The projects were also chosen as they represent typical projects executed in Finland with the two main wind turbine types sold, even if the turbine types are very different in size and power output the site construction material and services are similar to both turbine types and both are included in research and has the most up to date cost data. Even fewer projects could have

been chosen but as some projects had used different suppliers for material and services it was better to include as many as possible to get better understanding of the supplier base and cost level.

4.2 Purchase Order Data Collection

When the projects had been defined their purchase order data for was retrieved from the internal ERP system where the purchase order history can be accessed through a transaction which gives a full report on purchases that has been made under a specific project. Specifically, the ME2J Purchase orders for Projects transaction was used and projects numbers entered as only parameter to get full list of purchase orders. The purchase order history is needed as the order can based on this be determined if they are imported or made out to vendors in Finland. The reports were then be exported into an Excel spreadsheet and put together with all other projects' purchase order history to make a summary that could be analyzed.

In the purchase order report the purchase group is defined, and this was filtered to only include the site construction material and services purchase orders according to scope of research meaning all main transport related orders, orders made internally for wind turbine components and orders for site personnel for supervisory and management roles were filtered out as this is not in scope of the research. By looking at the supplier used for each order in the purchase order summary it could be determined which orders had been made out to suppliers outside Finland based on the country code of the supplier so this way the number of imported orders could be determined. The transport or mobilization costs to the construction sites of the orders shown separated from material or service could then be determined manually and gathered. I was noted however that some orders lacked the line for transport or mobilization as this had likely been included in the total price for material or service. This will make the result not as accurate as if all orders would have the same set up with a line specifically for transport or mobilization. For this thesis it is crucial to determine the specific cost for transport and later on determine the potential financial and emissions savings. For the orders not including specific order lines for transport and mobilization they were further investigated, and some additional order lines were replicated so it would give a more truthful result of the transport cost ratio.

4.3 Category segmentation

The material and services were grouped into different categories according to their characteristics of the material or service for the construction project. The categorization was done before the spend analysis as opposed to the category strategy described in chapter as the objective for the thesis is not to single out any particular supplier but focus on product categories.

When the spend analysis was completed as described in the next sub chapter, the categories could be inserted in the Kraljic model. This was done together with a strategic purchaser and supervisor which gave their input in addition to the purchasing data reviewed. It was here very important to get their input as the sourcing strategy was explained to the writer and more information was given regarding the long-term planning and supplier relationship and development activities.

4.4 Spend analysis

When the categorization was done a spend analysis could be performed using the Pareto model which depicts which categories are the main cost drivers. It could quite quickly be determined based on the spend amount which the key cost driver materials and services were. Most of the effort should thus be focused on getting alternative offers and find most suitable supplier for the items. In the following result chapter, it can be seen which product categories this refers to. The spend analysis is using the Pareto model which has a function in Excel which visualizes the spending in a diagram showing the level of spending per category in relation to the total spending as seen in figure 9.

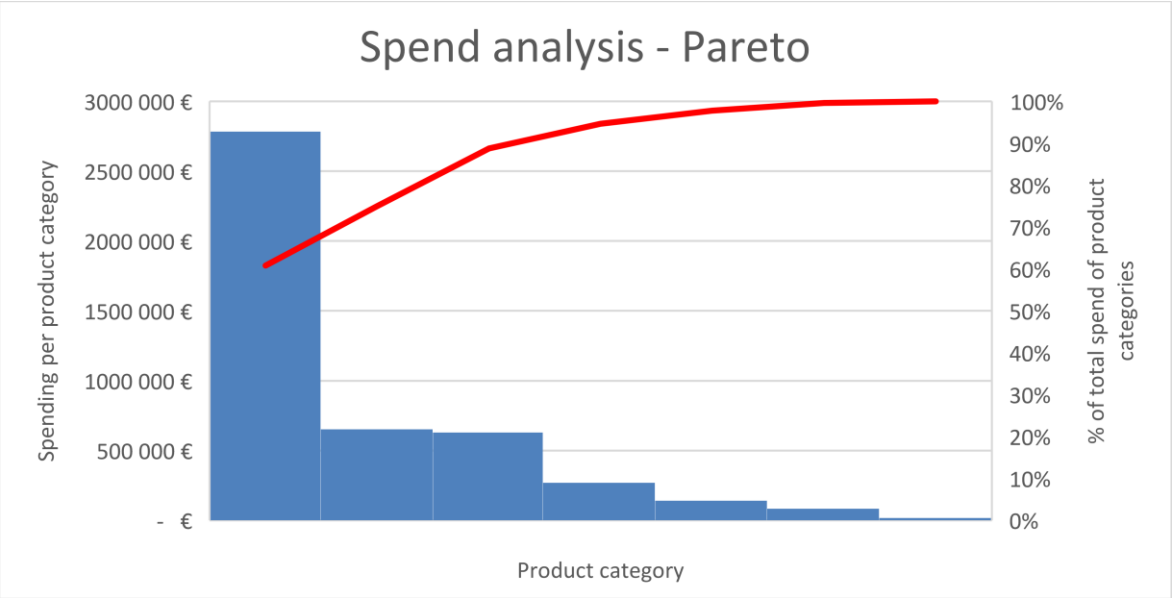

Figure 9. Spend analysis for product categories. Costs and product categories not included as they are business sensitive.

The percentage of transport cost compared to total cost of category spend was also calculated. With the result from this the writer can give recommendation to the purchasing department on which categories to spend most effort on and which is of lesser importance in order to reduce waste in transport cost.

4.5 Supply base evaluation

After category segmentation and spend analysis, the writer could go through the material and services which possibly could be sourced from a local vendor in Finland. The options were reviewed with the purchasing team which have the knowledge base of the supplier capabilities. Then the writer contacted supplier with offer requests to registered suppliers to get reliable pricing of services or material or check if the same type of service or material had been sourced from a Finnish company not yet registered but showing potential. Before sending offer, the purchasing team helped review the suppliers, so they met initial qualifications. The new offers and prices can then be compared with historical purchase orders and offers, and it can be determined if there are viable economical and sustainable options to switch supplier.

For the collection of alternative offers the writer turned to the sourcing department as they have an assigned strategic purchaser supporting projects executed in Finland. They could give an accurate overview of what type of products and material the registered suppliers were able to offer. Other experts were also interviewed to get detailed information which the construction projects were requiring or wanted to improve. With this help the writer could also retrieve information on which companies Vestas has been in contact with and tried to implement as a supplier for certain material and services which had been recognized that there was a need for local supplier implementation. Once the review of new suppliers was done offer requests were sent out are identical to the already established vendors to get as a comparative offer back as possible. Already onboarded suppliers were included in review, and some were requested if they could broaden their scope of material supply or services. It was imperative that at least one local supplier would give an alternative offer per product category.

By following the strategy of supply base optimization as described in chapter 3.4 the writer could see how the spending within a product category was split between suppliers and if it could be identified which suppliers should be developed more and which should be eliminated. This goes in parallel with the purchasing strategy as Vestas is currently working on of optimizing their supplier base.

While asking relevant stakeholders for their support and input it was also discovered that some or the product categories were developed by other departments within Vestas to support the demand on material. This is more disclosed in chapter 5 for the relevant product category.

4.6 Sustainability review

The sustainability evaluation of the current supplier options was based on the CO_2 emissions produced by the transport of material or services and how much CO_2 emissions could be avoided by using other options to the current supplier alternatives. As economical factor of sustainability is covered with comparing the costs and pricing retrieved from the supply base evaluation it is also considered in this research. The environmental sustainability factor was considered by the calculating the CO_2 emissions for the alternatives for the different product categories. This was done according to the previously

mentioned model in chapter 3.2 to make an estimate of the carbon footprint of transport operations by using the formula:

CO_2 emissions = tonnes transported x distance travelled x g CO_2 emissions factor per tonne-km

The material weight was determined by the purchasing orders specifications which in some cases was stated or by requesting information for suppliers. Material weight could also be determined by examining the specifications of the material in the offer requests given on alternative products. The distance was given by asking the supplier which routes they usually plan for their transport to Finland and in some cases were this wasn't known the optimal route was plotted by the writer using Google maps to determine a distance from supplier to the construction site. The CO_2 emissions factor was taken directly from report *Measuring and Managing CO_2 Emissions of European Chemical Transport* and can be seen in table 1. The CO_2 emission calculated is only for the material itself so packing material, additional equipment or workers themselves are not accounted for in the weight transported.

Each category had an emission example calculated where the most common supplier option was taken and compared to potential option of a local supplier. The difference of emissions is effectively the avoided emissions that could be saved by using a local supplier can be calculated. Only one construction site, chosen at random, per product category was considered during the emission calculations as it was deemed to be enough to get a close enough estimate for the alternatives.

For product categories with only manpower mobilization from other countries than Finland and no material being transported the ICAO Carbon Emissions Calculator. This calculator is estimating the CO_2 per aircraft passenger. CO_2 emissions per passenger take into consideration the load factor and are based only on passenger operations. The steps for the estimation calculator of CO_2 emissions per passenger:

Step 1: Estimation of the aircraft fuel burn

Step 2: Calculation of the passengers' fuel burn based on a passenger/freight factor which is derived from RTK data

Step 3: Calculation of seats occupied (assumption: all aircraft are entirely configured with economic seats). Seat occupied = Total seats * Load Factor

Step 4: CO_2 emissions per passenger = (Passengers' fuel burn * 3.16) / Seat occupied

(International Civil Aviation Organization, 2022)

There are more sustainability factors that could have been taken into account for the supplier evaluations such as percentage of recycling of material, product efficiency of material, waste generated or social sustainability factors. For some of the product categories there are alternative solutions provided by different suppliers which have their own environmental affects and direct emissions. These are not included in the sustainability review as the objective for the thesis is to focus on the transportation and cost benefits of products and workers and not on the energy effectiveness solutions provided. For Vestas own KPI the CO_2 emissions are a key target to keep track of and this makes it logical to analyze the emission levels of the different alternatives brought up in chapter 5.

There is a possibility here to do further studies in the supplier evaluation and development and take into account their product methods, material choices and sub-suppliers sustainability ratings to get more of the value chain included in sustainability review. This would give a more holistic view of the value chain and provide more accurate sustainability rating than just reviewing transportation and cost efficiency. This is however following the strategy of efficiency in supply chain management to do more with less resources.

5 RESULT

6 DISCUSSION

In this chapter the method of the research and result will be discussed from a broader point of view. The main take away from the result which are important for Vestas and other concerns found during the research are presented.

Part of the method was done by discussions held with the purchasing department to learn more about the Vestas way of working and how active they are with developing suppliers and conducting market research. It was found that unless there was a strong need for new supplier in a product category there was no active market analysis ongoing as there are not enough resources to compare the market to current suppliers. The project teams need to be more active is highlighting issues with suppliers, availability or supply base as they are the ones closest to the suppliers. It is understandable that market research is not done for mature markets and supply chains but with the strong growth in the Finnish market it could be argued that was a need to review the supplier base used to keep up with demand. By highlighting the findings from this research, the writer hopes that effort will be put firstly into the large spend product categories as there is a considerable need for supply base improvement. The purchasing team need to evaluate if this is aligning with the sourcing strategy. Vestas has a clear sourcing strategy in limiting the number of suppliers in order to keep up with the negotiations of annual agreements and developments of current suppliers. This understandable as there is an increase of administrative work with maintaining a large number of suppliers as described in chapter 3.4. The recommendation is to have a stricter supplier evaluation to have the most suitable suppliers in the supply base.

Contacting possible suppliers with the purchasing team and requesting offers for a service or requesting a current supplier extend their scope to include more of needed material and services showed to be challenging. Some of the current suppliers were reluctant to purchase new equipment unless it could be promised that Vestas would use them in a number of upcoming projects. For Vestas this could be a risk as neither price nor availability was secured by the supplier during negotiations. With potential suppliers it was discovered that the Vestas onboarding procedure of new suppliers is quite complex and includes strict payment terms which was a challenge for a specific supplier. Due to these delays in

agreements with suppliers some of the product categories has used estimations in pricing to either way give possible scenario with successful supplier development.

Another finding during discussions with purchasing team and project team is that the risk of using a new supplier makes it difficult for new suppliers to be implemented. There are different levels of risks in the product categories and for the high-risk product categories where new suppliers would need to be implemented the purchasing department would need to discuss with project teams in case, they are willing to test a new supplier. The project teams together with purchasing department need to think about the long-term possibilities and discuss how to evaluate the risk and opportunities of using a new supplier. In the long-term supply base development, it is still important to get new suppliers tested if there is a need to expand number of suppliers.

During the research the historic purchase data from projects executed in Finland 2020 – 2021 was gathered and reviewed. While doing this the writer could notice that there is a concern about the validity of the used historic purchase order data and the identified transport and mobilization costs. As the order are manually made by different project team members, they have a tendency to vary in set up and distribution of order lines. Many orders to the same supplier for the same product or service had different levels of itemization and thus some stated only a total cost for the order while other specified products separately with transport cost of a specific order line. This makes the assumptions of transport and mobilization costs inaccurate and assuming to be lower than actual costs but in the case of the research there was not feasibly to distinguish this cost in any other way than reviewing the order line description. The result is either way showing the possibility to reduce the transport costs further for several product categories.

With the input from the result of the thesis the project teams can be informed about the most suitable supplier to be used in the construction projects executed in Finland. For several of the product categories there is already implemented local suppliers which can supply material and there is no actual need to use a vendor located outside of Finland as both material and transport cost was the lowest for other product categories further supply base development is needed.

When it come to the sustainability review both the economic and environmental aspects are included but the social aspect is intentionally left out. The reason being that the social

aspect is very difficult to measure and compare to alternative options in the supply chain. More thought and time would need to go into making a reliable social performance measurement for Vestas supplier. The same can be said about a sustainability score. In the supplier evaluation made initially when suppliers are considered to be used or even after having been implemented in Vestas and is used regularly there is no sustainability performance measurement. This is something that the writer is seeing a big gap in understanding the true sustainability impact of each order made out to a supplier. Discussing this with the purchasing department it is however under development.

7 CONCLUSION

In this chapter the conclusions of the research and findings will be presented. Further research and development options are also presented.

After collection of historical purchase order data, it was concluded that within the scope for the research 598 out of order lines were made out to suppliers outside of Finland and thus imported. Out of these 598 order lines 138 were directly identified as transport or mobilization costs. This was concluded by reviewing the available historical purchase data from ERP system after selecting the projects executed in Finland in 2020 and 2021. The orders were then categorised into 7 product categories according to the purpose of the material or services in the order. After a spend analysis was done for each of the product categories and supplier share of each of the product categories the supplier alternatives were evaluated and if no other suitable registered supplier were available possible new suppliers where contacted. These were first selected based on entry requirements made by the sourcing department at Vestas. Several offers from different suppliers in the product categories was collected to possibly be able to lower transportation costs and overall costs of the product category. After alternative alternatives had been identified and offers received an analysis of the current supply base situation and potential one was done, and the sustainability review focused on emission impact form transport done. The emissions were estimated according to carbon footprint of a transport operation by using a calculation model by the European Chemical Transport Organisation, see chapter 3.2.

From the alternative solutions gathered there is a potential cost saving of over 10 000 € per turbine and over 1 300 kg of CO_2 that can be avoided by using already registered suppliers in Finland and implementing a couple of new suppliers.

While the findings show that there are benefits in using local suppliers to reduce transport and overall costs and CO_2 emissions caused by long transport distances it's not aligning with the sourcing strategy of Vestas which is to reduce number of registered suppliers. By reducing suppliers in the same product category, the administrative work of maintaining and negotiating agreements with several supplier will be reduced, and more focus can on long-term agreements and development together with suppliers. This means that supply

base need to be further evaluated to get the most suitable suppliers registered and used for the construction projects in Finland.

7.1 Further research and development

Vestas should be more aware of the alternative suppliers in new or growing markets to better be able to respond to the demands of the projects. There can be a risk of relying to much on current supplier base in case these are not allowed or can supply projects in new markets with material or services. This is however not in line with Vestas current sourcing strategy as resources are put on supplier maintenance and development.

In order to get a better understanding of the total emissions caused by a product a total value chain analysis would be needed. The research done for this thesis only investigates a small part of the total emission caused and thus does not reveal the full impact from raw material to the final stage of a product's lifecycle. This would require much more time and effort but is nevertheless important in case Vestas want to continuously improve their sustainability targets.

7.2 Final words

I want to thank Vestas for allowing me to take time to research this topic within my organization to learn and develop how the construction projects are being supplied with material and services. I appreciate the support I have received from my manager and supervisor from Vestas, Wiebke Storm, and other colleagues in the purchasing department and project teams that have given their input and knowledge. A big thank you to my supervisor from Novia UAS, Mikael Ehrs, for guiding me through the thesis process.

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