Practical Guidelines and Recommendations for Selecting and Managing Environmental Key Performance Indicators for 1st Tier Suppliers

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Abstract

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Keywords

Key Performance Indicator, Green Supply Chain Management, Environmental Performance Measurement, Environmental Performance Indicator, KPI Selection, Data Collection, Implementation Strategies, Energy use, Greenhouse Gas Emission, Raw Material Handling, Waste Handling, Water Use

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Praktiska råd och riktlinjer för val och hantering av miljönyckeltal för direkta leverantörer

Sammandrag

Denna uppsats har utforskat praktiska angelägenheter för val och hantering av nyckeltal för verksamheten för att hantera miljöpåverkan från leverantörers tillverkningsprocesser för leverantörer uppströms i leverantörskedjan. Studien har genomförts genom intervjuer med fem framstående företag inom området. Forskningsresultaten visar att det främst är direkta leverantörers miljöproblem kring energianvändning, utsläpp av växthusgaser och vattenanvändning som företag följer. Nyckeltalen som används är främst absoluta eller normaliserade. För att förbättra leverantörernas miljöprestanda använder företagen sig av traditionella medel så som balanserade styrkort och att sätta upp mål. De förser även leverantörerna med teoretiska och praktiska hjälpmedel för att höja deras medvetenhet och kunskap. Ett antal faktorer begränsar företagen i deras arbete. En sådan faktor är det helt manuella datarapporteringssystem som används, vilket är förknippat med en stor arbetsbelastning. En huvudupptäckt är de strategier som företagen använder för att framgångsrikt implementera nyckeltalen. Allt som allt erbjuder den här uppsatsen praktiska råd och riktlinjer för ett företag som är på väg att införa miljönyckeltal för deras direkta leverantörer. Uppsatsen identifierar också nyckelproblem som måste utforskas vidare av framtida forskning.

Nyckelord

Nyckeltal för verksamheten, Miljömässig flödesekonomi, Mätning av miljöprestanda, Nyckeltal för miljöprestanda, Val av nyckeltal för verksamheter, Datainsamling, Implementeringsstrategier, Energianvändning, Utsläpp av växthusgaser, Råmaterialhantering, Avfallshantering, Vattenanvändning

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Practical Guidelines and Recommendations for Selecting and Managing Environmental Key Performance Indicators for 1st Tier Suppliers

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“You can’t manage what you don’t measure”
– General management saying

Preface

This thesis has been conducted at the Quality Social Environment (QSE) department of IKEA Components AB (ICOMP) in Älmhult together with the International Institute for Industrial Environmental Economics (IIIEE) at Lund University (LU).

ICOMP is a purchaser of raw material and designer of components such as fittings and lighting for IKEA products. The production of the components is outsourced to external companies. The raw material and components are then sold to IKEA suppliers contracted for manufacturing the products found in the IKEA stores. Since the production is outsourced, the majority of ICOMP's environmental impact comes from its suppliers. As a base for discussion of future strategies to lower this environmental impact, ICOMP requested a research study about the use of environmental KPIs upstream in the supply-chain.

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Last but not least my family, friends, and Maria Sörensson (LU) for supporting me throughout my studies.

Abstract

This thesis has explored practical concerns for selecting and managing environmental Key Performance Indicators (KPIs) to manage environmental impacts of suppliers' production processes upstream in the supply-chain. It has been accomplished by interviews with five front-runner companies. Findings show that companies primarily track environmental issues for 1st tier suppliers concerning energy use, greenhouse gas emission, and water use. The used KPIs are mainly absolute and normalised indicators. To improve the suppliers' environmental performance the companies use traditional means such as targets and supplier scorecards. They also provide theoretical and practical support in order to raise the suppliers' awareness and knowledge-level. The companies are limited by a number of factors. One such factor is the completely manual data reporting system, which is associated with a heavy workload. A key finding is strategies for implementing the KPIs to guarantee a high compliance rate. Altogether this thesis provides practical guidelines and recommendations for a company on the way to implement environmental KPIs for its 1st tier suppliers. It also identifies key problems that need to be addressed by future research.

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Acronyms

BOD	=	Biological Oxygen Demand
CO_2(e)	=	CO_2 equivalent
COD	=	Chemical Oxygen Demand
CSR	=	Corporate Social Responsibility
GHG	=	Greenhouse Gas
GSCM	=	Green Supply Chain Management
KPI	=	Key Performance Indicator
LCA	=	Life Cycle Assessment or Life Cycle Analysis
TSS	=	Total Suspended Solids
WF	=	Water Footprint
WFAM	=	Water Footprint Assessment Manual

Terminology

The terminology differs within the areas of Green Supply Chain Management and Performance Measurements. To avoid any misconceptions the used terminology in this thesis is hereby stated together with corresponding synonyms.

Green Supply Chain Management	=	Environmental Supply Chain Management, Supply Chain Environmental Management
Environmental KPI	=	Environmental Performance Indicator, Environmental Performance Measure, Environmental Performance Metric, Sustainability Performance Indicator
Target	=	Goal (concerning KPIs)

1 Introduction

Every company is part of a supply-chain, or actually a multitude of supply-chains that are interconnected. Each supply-chain includes all related production processes and logistics of a product from extraction of raw materials to the products' end-of-life, see figure 1.1. The company of interest is designated as the "focal company", e.g. IKEA Components AB. This company has a number of direct suppliers called 1st tier suppliers. The 1st tier suppliers in turn also have direct suppliers, which are called 2nd tier suppliers. The tier level increases like this for each step towards the raw material extraction (called upstream in the supply-chain). (Handfield and Nichols, 1999)

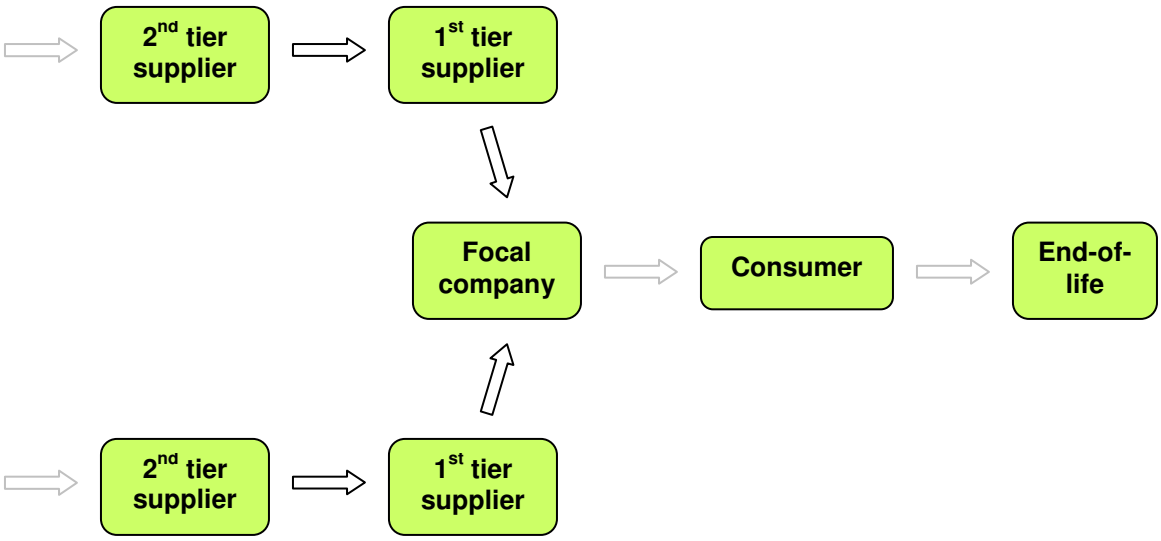

Figure 1.1: Schematic overview of a supply-chain.

At each step of the supply-chain one or several products are either processed or transported. Each step will therefore consume resources (e.g. material, energy, and water) and generate emissions and waste (e.g. scrap, greenhouse gases, and polluted water) (Handfield and Nichols, 1999). The resource use, emissions, and waste can be seen as an ecological footprint. The size of this footprint corresponds to the amount of land that is required to regenerate and sustain an average customer's needs. The larger the resource use, emissions, and waste generation are, the larger will this ecological footprint be (Hart, 1997; WWF, 2010). In 2007 the whole world's current ecological footprint corresponded to 1.5 planet Earths. If the entire world's population lived like an average citizen of the United States of America or the United Arab Emirates, this figure would be as big as 4.5 planet Earths. If nothing changes, we would need 2.0 planet Earths to sustain our demands by 2030 (WWF, 2010). This planet is therefore stressed beyond its capacity. A further problem related to the ecological footprint is global warming. This not only poses a major environmental threat; it will also damage future economic growth and is therefore a major business risk. As Stern (2006, p. i) concludes: "The benefits of strong, early action on climate change outweigh the costs."

Since a large part of a company's environmental impact comes from the supply-chain there is a need to manage it. This practice is called Green Supply Chain Management (GSCM). While the use of filters and other end-of-pipe solutions can lower emissions, it will not remove the actual cause of the environmental impact. End-of-pipe solutions are also a cost since a filter has to be taken care of. It is therefore more beneficial for companies to take a value-seeking approach. In this approach greening efforts are seen as an advantage instead of a burden. This approach also results in increased competitiveness. One strategy to achieve this is through a more efficient use of resources. This results in cost-reductions, waste elimination, and an overall productivity improvement (van Hoek, 1999). To enable this it is essential that the corporate management evaluates its ecological footprint through performance measurements, since you can't manage what you don't measure (Ditz and Ranganathan, 1997). To accomplish the performance measurements it is vital to use environmental Key Performance Indicators (KPIs) (Hervani *et al*., 2005). An example of an environmental KPI is the absolute water consumption of a supplier. Let's say that the water consumption of the supplier during one year is 8.3 million m^3. The next year it has decreased to 7.3 million m^3. Through the environmental KPI the focal company can see that the supplier has improved its absolute water consumption by over 10 %. There are however more environmental aspects than water that are important to report on. Also, more than one KPI per environmental aspect is often needed.

There is a lot of research conducted on environmental performance measurements (Bennett and James, 1999; Ditz and Ranganathan, 1997; Hoekstra *et al*., 2011; Kuhre, 1998; GHG Protocol, 2004), its importance for greening the supply-chain (Ditz and Ranganathan, 1997; Hervani *et al*., 2005; Hoekstra *et al*., 2011; van Hoek, 1999; GHG Protocol, 2004), and how to design a GSCM system (Handfield *et* al., 2005; Hervani *et al*., 2005; Hu and Hsu, 2010). However, practical concerns for selecting and managing the environmental KPIs *upstream in the supply-chain* are not well-described in the literature. The objective of this thesis is therefore to establish guidelines and recommendations for these two aspects. This will hopefully fill a gap in the literature. It should also provide a practical guide for companies using or starting to use environmental KPIs for their supply-chain.

1.1 Research Questions

To accomplish the research objective two research questions, including sub-questions, are defined:

Research question 1: To what extent do front-runner companies use environmental KPIs to manage the environmental performance upstream in their supply-chain?

a. Which environmental aspects do they track on?
b. What types of KPIs are used?
c. How do they implement the KPIs at their suppliers?
d. Which methods and tools are used to collect data for the KPIs?
e. What actions do they take to increase the suppliers' KPI performance?

Through this research question it will be possible to see how far front-runner companies have come in using environmental KPIs for their supply-chains. Sub-questions a. and b. will detail which environmental aspects a company has focused on. It will also provide information about which KPIs are used to report on these aspects, and if and how the KPIs differ between the different environmental aspects. To study the management of the environmental KPIs, three areas were selected. These three areas are: how to implement the KPIs, how to collect data for them, and how to improve the suppliers' KPI performance. Through the answers to all five sub-questions it will be possible to visualise patterns between the different practices of the companies. These patterns will give an indication of what the current common standard is. They will also serve as a basis for which guidelines and recommendations should be set.

Research question 2: What challenges have the companies experienced concerning the selection, implementation, data collection, and performance improvement of the environmental KPIs?

a. Are there any solutions to these challenges? If so, which?

By identifying which challenges the different companies have faced it will be easier to establish guidelines and recommendations that help other companies avoid these challenges as far as possible. By combining findings in literature and the different company practices it might also be possible to find solutions to these challenges. If no solution can be found to a challenge and it cannot be avoided, informing about it will at least prepare a company of what is to be expected. Such challenges will also provide recommendations for future research.

1.2 Scope and Limitations

Although there are many important environmental aspects in the supply-chain, four environmental categories that are of extra interest were selected by IKEA Components to be studied in this thesis. These are:

- **Energy use and greenhouse gas emission:**
  Energy use and greenhouse gas emission cover how much energy is used by a supplier (e.g. MWh), how much greenhouse gas it emits (e.g. CO_2), and which energy sources it uses to cover its energy demand (e.g. electricity and oil). By selecting different energy sources the cost and amount of emitted greenhouse gas will differ. The reason is that some energy sources are cheaper than others (e.g. coal compared to wind power). Some energy sources also emit less greenhouse gas than others (e.g. biofuels compared to oil). The greenhouse gas emission generated by the use of electricity varies between different countries since they use different mixes of energy sources for the electricity generation. It also varies with what type of contract a supplier has with its electricity supplier, as some agreements guarantee that e.g. only renewable energy is provided.

- **Raw material handling:**
  Deals with (raw) material issues such as how much material is used (e.g. tonnes), what type of material (e.g. recycled, reused, and renewable), and the yield (how much of the purchased material ends up in the products). The selection of material is important for improving the environmental performance of the total cradle-to-gate perspective of the company's supply-chain. Although it is important to lower the amount of used natural resources, e.g. energy, material, and water in the existing production processes, a lot can be achieved by changing what type of materials that are used. For example, the use of recycled materials does not require extraction of additional virgin material.

- **Waste handling:**
  Regards waste issues such as the amount of generated waste (e.g. tonnes), what type of waste it is (e.g. toxic/non-toxic), and how the waste is treated after it is generated (e.g. landfilled or recycled). Waste is an important issue as all the materials that are used in a production process cannot be turned into a product. The rest becomes waste that has to be handled in some way, e.g. sent to a landfill. Another strategy is to reduce the amount of waste that was generated in the first place. This latter approach is to be preferred as it means that more of the material that was purchased can be sold as part of a product. In some cases waste can also be sold, but never at the same price as the product.

- **Water use:**
  Water use deals with issues such as how much water is used for a production process (e.g. m^3) and from which source (e.g. tap, lake, rain). It also deals with how much is recycled after use, and what the quality of the water is when it is discharged (e.g. oxygen level and concentration of chemicals). The water does not have to be used directly in production processes (e.g. cleaning, diluting or dissolving). It could also be used indirectly as part of heating or cooling systems, causing thermal pollution of the water. Which water sources a supplier uses depends on the level of infrastructure in the region it is situated in. For example, lake or river water is more used in regions where tap water is not available. It also

depends on requirements on water purity in the processes since for example lake water is dirtier than tap water.

A mapped front-runner company does not have to track all four environmental categories, as long as it tracks on at least one. Neither does the company have to have tracked them for a long time, but it is preferred. Since this thesis will be used by IKEA Components it is also important that the studied front-runner companies have a similar business structure to IKEA Components. The companies' suppliers therefore have to be external. In other words, the companies must not own or be share-holders of the suppliers that report using environmental KPIs. The suppliers should preferably also be globally spread and the company's production should at least to some degree be outsourced.

Handfield *et al*. (2002) points out that the environmental performance of a supplier can either be described at a corporate level or at a product/service level. This thesis will focus on the latter, and more precisely on the production process of a supplier. It will therefore not focus on environmental KPIs that e.g. track if a supplier is ISO 14001 certified or not. Unless otherwise stated, the terms environmental KPIs and KPIs are hereon used for environmental KPIs concerning the production process of a supplier.

There were a number of limitations for this thesis. One such factor was that it was hard to get in contact with the companies, and if the companies answered it took time to find a suitable person that could describe how they used environmental KPIs for their suppliers. The study was therefore very dependent on external recommendations on whom to contact, and direct contact information to these people. Almost all of the people that were contacted were managers or directors, and some did not have the time to participate within the timeframe of this study. Since recommendations were important to acquire contact information, the final selection of companies which are featured in this thesis is coloured by the geographical location of where this thesis was conducted (Sweden). This caused four out of five featured companies to be Nordic companies. However, it should be noted that there were five additional companies that were interested in participating, but were unable to do it within the limited timeframe. Two of these were North American and two others were European (non-Nordic) companies. The fact that four out of the five featured companies are Nordic is therefore partly by chance.

Another limiting factor was that almost 50 % of all the contacted companies declined to participate since they did not yet have environmental KPIs for their suppliers. It therefore seems as if environmental KPIs for suppliers are a rather new area for companies. The sensitivity of the requested data did not seem to be a limiting factor as all companies willingly shared it. However, since the data still is sensitive, the companies remain anonymous in the thesis. The final limitation was that the companies only tracked the environmental performance of 1st tier suppliers. No research could therefore be done on any deeper tiers.

1.3 Structure of the Thesis

The thesis is divided into five parts (apart from this chapter). In chapter 2 the theory of GSCM and general KPIs is first expanded for better understanding of the area. It will also provide a foundation for future analysis and discussion of the findings. Current reporting standards for environmental KPIs are also briefly described, e.g. the GHG Protocol. With that set, chapter 3 "Methodology and cases" explains the methodology that was used to select and evaluate the front-runner companies, along with a short description of each selected company (case study). In chapter 4 "Analysis and findings" the results from the case studies are presented. The aim is to find patterns from these results. The patterns and findings are then further discussed in chapter 5 and compared towards what is described in the literature. From this discussion practical recommendations will be set for how companies should select, implement, collect data for, and improve the performance of environmental KPIs for suppliers. The thesis then concludes with chapter 6 "Conclusion" where the research questions are answered and the key findings are presented as well as suggestions for future research.

2 Theoretical Background

In this chapter the concepts of environmental KPIs and GSCM are explained, and to some degree also problematised. Two reporting standards are also explained: the GHG Protocol and the Water Footprint Assessment Manual.

2.1 Basics of General and Environmental KPIs

According to Neely *et* al. (1995) a KPI is a metric to *quantify* how well an action taken by a company has met its customer demands and/or how well the company's resources have been used to reach this. An important aspect of KPIs is that they are used in a strategic context since they have a behavioural influence on what actions people take. Traditionally, KPIs have been used to report on business aspects such as cost, time, and quality (Neely *et al*., 1995). They can also be used to report on, or track, environmental aspects and are then often called Environmental Performance Indicators (Hervani *et al*., 2005). However, in this thesis they are called environmental KPIs. Generally a KPI can be used internally in combination with business goals to evaluate how successful the company has been in reaching these goals. It can also be used externally to compare, or benchmark, the company's performance against its competitors or to ensure customer satisfaction through surveys. Several KPIs make up what is called a performance measurement system. (Neely *et al*., 1995)

A well-designed KPI is made up by the following 14 elements (Neely *et al*., 1997):

- **Title:** Should be self-explanatory.
- **Purpose:** The reason to why the KPI is used, e.g. monitor the rate of improvement of the suppliers' water use, driving down their total water consumption.
- **Relates to:** Which business objective does the KPI relate to? If it does not relate to an objective then it is questionable if the KPI should be used.
- **Target:** How much should the performance of the KPI improve? Important aspects are by how much, within which timeframe, and using what baseline.
- **Formula:** How is the KPI calculated and what parameters are used? It is essential to define this correctly as it is the formula that influences how people act on the KPI. As Neely *et al*. (1997, p.1139) explains: 'Take, for example, a measure such as value of new products won. This appears to be an appropriate measure for a sales manager. But if the formula is value, in terms of "£", the measure may encourage sales managers to seek large contracts, rather than profitable ones. Hence, perhaps the measure should be contract contribution, but the problem with this is it might stop sales managers pursuing new business opportunities, even if they are of strategic significance'.
- **Frequency of measurement:** How often the data for the KPI is measured (hereon referred to as "reporting frequency").

- **Frequency of review:** How often the data is reviewed in order to identify e.g. production problems and take actions for improvement.
- **Who measures:** The person responsible for collecting the data.
- **Source of data:** The raw data that is used for the KPI.
- **Who owns the measure:** The person that is accountable for ensuring that the performance of the KPI improves.
- **What do they do:** What actions does the person take to ensure this?
- **Who acts on the data:** The person that actually takes action to improve the performance of the KPI.
- **What do they do:** What actions does the person take to ensure this?
- **Notes and comments**

Based on how a KPI is calculated it can be classified into different indicator types. The terminology used in this thesis will be the one used by Bennett and James (1999) as a contrast to the terminology used in the ISO 14031 standard. The reason is that their terminology is compliant with the one used by the GHG Protocol and the majority of the interviewed companies in this thesis.

- **Absolute:** The total amount, e.g. total water consumption. The "basic" indicator from which the following three indicator types are derived.
- **Normalised:** Describes an amount in relation to another business metric, e.g. amount of water used per production volume. It is in a way a measure of efficiency. How the absolute amount is normalised depends on the allocation unit, e.g. production volume (kg, units produced) or turnover (monetary unit).
- **Consolidated:** An indicator for the same type of data, but where the data originates from different sources, such as the total water consumption of all supplier factories.
- **Indexed:** Data which is modified by applying a weighting factor in relation to the importance of the data or its properties.

Based on the situation that these indicator types are used in, and how easy it is to acquire all the necessary data, the indicators will have different advantages and disadvantages. For environmental KPIs, Bennett and James (1999) argue that too much emphasis should not be put on normalised indicators. The reason is that the benefits of an improved efficiency can easily be offset by an increase in production volume. A reduction in the absolute amount is therefore the most important, but normalised indicators can be a complementary way to reach this.

When selecting environmental KPIs for a performance measurement system, it is important that the environmental KPIs have certain characteristics. The "ISO 14031:1996 Environmental management – Environmental performance evaluation – guidelines" (Kuhre, 1999) has recommendations of 18 such characteristics, of which a few will be

explained below. (This is an older version of ISO 14031. The latest is ISO 14031:1999, however no review of it could be found.)

- **Representative:** The KPI must be representative of a company's operations and should focus on the major environmental aspects of the company which it actually can control.
- **Point to root cause and prevent problems:** The KPI must not just report on observed impact. Instead it should be preventative in solving the root cause of the observed impact.
- **Simple and understandable:** The indicator must be easy to understand and use by all who work with it.
- **Not too many, not too few:** The number of used KPIs must be balanced so that they cover all major environmental aspects, but at the same time are manageable. Too many KPIs can also make it hard to communicate which ones that are the most important.
- **Promotes benchmarking:** The KPI should be possible to benchmark against competitors to further improve the performance and cost-efficiency of the performance measurement.
- **Can be applied with meaning over time:** A KPI must be designed so that it is possible to track the performance over time, without much need of tweaks to maintain its relevance despite changes in business conditions.
- **Relate to a cost:** As most actions within a business organisation are related to increasing the profit, it is recommended that a few KPIs relate to specific costs.

According to Ditz and Ranganathan (1997) the KPIs should also be standardised in order to increase the transparency and enable benchmarking between companies. Apart from the GHG Protocol, there is currently no structured approach to which actual environmental KPIs should be used. Instead, the general approach in the literature is to give examples from the ISO 14031 guidelines, which just lists possible environmental KPIs without much structure behind it.

2.2 Introduction to Green Supply Chain Management

As mentioned in the introduction, the practice to manage the environmental impact of the supply-chain is called Green Supply Chain Management, or GSCM. There are many definitions of what is actually incorporated into this practice. In this thesis the definition by Hervani *et al*. (2005) will be used. In this definition GSCM consists of the following four elements:

- Green Purchasing
- Green Manufacturing/Materials Management
- Green Distribution/Marketing
- Reverse Logistics

Green purchasing is the practice to incorporate environmental requirements into the "standard" requirements such as cost and quality when purchasing/sourcing from a supplier. Green purchasing requirements can concern how "green" the manufacturing process is, or which materials are used in the products. The compliance of these environmental requirements can either be evaluated through for example a Code of Conduct and/or a performance measurement system. By tracking the environmental performance of the suppliers and ranking them thereafter, the purchasing teams at the focal company can select/prioritise which suppliers the company should do business with (Hu and Hsu, 2010). To achieve such a ranking the environmental KPIs should be integrated into a balanced scorecard (or supplier scorecard) along with the traditional business KPIs. The higher a supplier's KPI performance is, the higher will the score be in the scorecard. A high score indicates that a supplier is more preferable to purchase from than others. The opposite is also possible; if the score is too low the business relationship might be terminated. Since the environmental KPIs are integrated with traditional business KPIs they will be placed in their proper strategic context and will not be neglected. It is therefore also important that the environmental KPIs can relate to business objectives and priorities, e.g. reducing costs (Bennett and James, 1999; Hervani *et al*., 2005; Kaplan and Norton, 1992). Through this strategic sourcing, companies can improve the environmental performance of their supply-chains (Handfield *et al*., 2002). Another important aspect of the supplier scorecard is that it enables rewards and recognition of a supplier's work to improve its environmental performance (Hervani *et al*., 2005).

While Green Manufacturing/Materials Management and Green Distribution/Marketing to some degree are self-explanatory, some explanation has to be given for Reverse Logistics. It has gotten its name from its practice to recycle and reuse products and materials in the supply-chain, for example from end-of-life. When a product is recycled or reused it will flow in the opposite way through the supply-chain. In that way it is "reverse". By reusing and recycling materials and products, less virgin material has to be extracted. This lowers the environmental impact. However, it does not reduce the environmental impact of the actual manufacturing process. Reversed Logistics and Green Manufacturing therefore complement each other. (van Hoek, 1999)

Besides taking actions for the four elements mentioned above, a high-performing GSCM is characterised by having a committed top-management. The top-management should realise the importance of the GSCM practice and support actions related to it. It is also important that a company has a cross-integrated approach. By this it is meant that representatives from different supplier-specific functional areas at the company work together to reduce the environmental impact of the supply-chain. This can be further emphasized by integrating the GSCM practice into already existing supply-chain management practices, e.g. including environmental aspects into a quality audit or sourcing (as explained above). A third feature of a high-performing GSCM is to have an effective communication platform – both within the company and towards the suppliers. This makes all involved parts aware of why actions are taken to manage the environmental impact of the supply-chain. They should also understand why it is important and what the consequences are for a supplier if it manages/does not manages its environmental impact (Hu and Hsu, 2010; Lippmann, 1999).

Apart from integrating the environmental KPIs into a scorecard, another method to improve the environmental performance of the supply-chain is to set targets. The environmental KPIs together with a supplier's ability to reach set targets can be used to quantitatively assess the supplier's environmental performance (Handfield *et al*., 2005; van Hoek, 1999). The process of designing a target, including determining its boundaries and the reduction amount, is complex and will not be discussed further in this thesis. However, the different target types will be discussed since the KPI type determines the type of target. The GHG Protocol (2004) has a good discussion about the two major target types. Although it concerns energy use and GHG emission the discussion is valid for the other environmental aspects as well. According to the GHG Protocol there are two main target types: absolute targets and intensity targets. Absolute targets relate to absolute indicators and therefore are targets to reduce the absolute amount. An example of such a target is to reduce the absolute amount of CO_2 with 25 % by 2025 (2005 baseline). One advantage of this type of target is that it reduces the actual environmental impact (since that depends on the absolute amount). It is also transparent to stakeholders since it is a specific amount. A disadvantage is that it is not possible to compare the energy efficiency. Absolute targets are also sensitive to fluctuations in production volume. If a company undergoes major structural changes, e.g. sells parts of the business, the baseline has to be recalculated since it was based on the previous operations. The absolute amount also changes if the production volume suddenly increases due to increased orders or decreases if the company is suffering a downturn and orders drop.

Intensity targets on the other hand concern the environmental impact relative to a business metric, just like the normalised indicators. An advantage of using this type of target is that it should be independent of fluctuations in production volume, unlike absolute targets is. It is also possible to compare the energy efficiency between suppliers. The baseline often does not have to be recalculated if major organisational changes occur. A disadvantage is that there is no guarantee that the actual environmental impact will be reduced since the efficiency gain can be offset by an even larger increase in production volume. Another problem is that it can be hard to define which business metric to relate to if the company has several different types of production processes. If total turnover or some other monetary business metric is used, there is a further problem with inflation and fluctuations in currency exchange rates. (GHG Protocol, 2004)

Environmental KPIs are an important part of GSCM. There is however some problems associated with it. These are similar to the ones for performance measurement in more "traditional" supply-chain management. First of all, the two parts (supplier and focal company) must trust each other. This is not necessarily the case since a lot of mistrust from both parts (supplier and focal company) has been experienced for "traditional" supply-chain management. A further problem is the lack of control. The focal company that evaluates the measurements cannot control the measurements as they are made by the suppliers. The suppliers on the other hand which make the measurements would like to evaluate their own measurements and not let anybody else do it. The suppliers can also lack an understanding of why the KPIs are important. The two parts often also have different business goals and objectives; to then agree which measures should be taken can be hard. There can also be a lack of common reporting standards. This can increase the

workload of the supplier. The reason is that the internal reporting standard of a supplier might not be the same as the ones used by its focal companies. If they differ, the supplier will have to use the other ones as well, thereby increasing its workload. Another problem is that companies' information systems are not necessarily able to handle non-traditional data for supplier performance. These problems have to be addressed in order to further improve the compliance and performance of environmental KPIs. (Brewer and Speh, 2001; Young and Kielkiewicz-Young, 2001)

2.3 Current Reporting Standards for Environmental KPIs

Common standards are identified as important for environmental performance measurements. Therefore, one common reporting standard for energy use and greenhouse gas emission and another for water use will briefly be explained. Apart from these there are currently no other common reporting standards for the environmental aspects discussed in this thesis.

2.3.1 The GHG Protocol

The GHG Protocol is a reporting and accounting standard established by the World Resource Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) in cooperation with companies, NGOs, and governments. Five principles form the basis for the reporting standard. First, the measured data should be relevant for decision making and reflect a company's business operations. Secondly, the measured data must be complete in the sense that all relevant emission sources must be accounted for. Thirdly, the data should be measured so that they are consistent over time, making it possible to assess the company's development and performance over time. Fourthly, the data and the measurements must be transparent so that they can be verified by an external reviewer. The fifth and last principle is that the data should be accurate by conducting the measurements systematically and in a way that minimizes sources of error. (GHG Protocol, 2004)

In order to accomplish this, the GHG Protocol offers guidance and tools on how to determine the boundaries and how to identify, calculate, track, verify, report, and reduce the GHG emissions. Through the guidelines a company can categorise its emissions into three different scopes. Scope 1 regards direct emissions from its own production. Scope 2 on the other hand concerns indirect emissions through purchased electricity for own use. Finally, scope 3 includes indirect emissions from production and transport of purchased materials (i.e. the supply-chain). In order to evaluate and compare the emission of different greenhouse gases, they are all reported as CO_2 equivalents, or $CO_2(e)$. One $CO_2(e)$ corresponds to the global warming potential of 1 unit of CO_2. To calculate the GHG emission of a production process the used amount of each energy source for this process, directly or indirectly, is measured; e.g. litres of oil or kWh of electricity. Through standard conversion factors these amounts are then transformed into $CO_2(e)$ or energy units. If any greenhouse gases are emitted from the production process itself these are included as well. One such example is the CO_2 emission from the calcination process

of limestone production. The GHG Protocol requires that absolute indicators are used while normalised indicators are optional. (GHG Protocol, 2004)

2.3.2 The Water Footprint Assessment Manual

Developed by the Water Footprint Network, the Water Footprint Assessment Manual (WFAM) is a recent standard for classifying, calculating, and reporting the water footprint and its impact for different entities. These entities can be a process step, a business, a group of consumers, a product, a nation, or humanity as a whole. The relevant aspect for this thesis is the water footprint for a process step or a business. Similar to the GHG Protocol, the WFAM provides guidelines on how to determine reporting boundaries. It also provides guidelines on how to assess the impact of the water use within these boundaries. A water footprint can also be seen as an analogue to the CO_2(e) of the GHG Protocol. The total water footprint consists of both a direct footprint (for a company's business operations) and an indirect (from the associated supply-chain). The impact of the water footprint does not only depend on how much water is used. It also depends on what *type* of water is used. The WFAM defines three types of water, each with their own respective water footprint (WF):

- **Blue water:** surface and groundwater
  $WF_{blue} = Evaporation_{blue} + Incorporation_{blue} + LostReturnFlow$ (1)
  [volume per time]
- **Green water:** rain (mainly for agriculture)
  $WF_{green} = Evaporation_{green} + Incorporation_{green}$ (2)
  [volume per time]
- **Grey water:** polluted water

For WF_{grey} there are a number of equations depending on what type of pollution is examined, e.g. chemical or thermal. For a full list of these see the WFAM. What the WFAM defines as used water differs from the "traditional" water consumption in several ways. First of all blue water is not regarded as consumed if it is returned unpolluted to its original source. Secondly, the water use does not only regard blue water, but also green and grey. Thirdly, indirect water consumption is also included. The WFAM also takes into account how much water that is vaporised in the production processes and how much water is incorporated into a product. Although little data exists for the indirect water footprint, the WFAM can still be useful as a common standard for classifying and calculating the water use of a supplier's production process. (Hoekstra *et al*., 2011)

2.4 Summary

The importance of KPIs to manage the environmental impact of the supply-chain is well-discussed in the literature. How to design KPIs, and fundamental characteristics to think of when designing them, is also well-described. For the KPIs to be effective it is important that they are placed in a strategic context. It is also important that they are part of a management system dedicated to manage the environmental impacts of the supply-chain. Such management is called Green Supply Chain Management. To improve the

environmental performance of the suppliers, targets connected to the KPI performance should be set. The KPIs should also be integrated into a balanced scorecard. By using global reporting standards, such as the GHG Protocol, the transparency is increased. The companies will also have the ability to benchmark against other companies. A company can also benchmark its suppliers against each other. The drawback is however that few such standards exist today.

Although a lot of theoretical research has been made, the practical implications of using environmental KPIs are not well-described. Little is for example discussed about the barriers the companies face when trying to implement the KPIs at the suppliers. For example, what barriers influence the reporting compliance of the KPIs? What steps can be taken in order to avoid or solve these barriers? Another area there is little information about is how to collect data for the KPIs, including how frequent it is feasible to do this. The literature also emphasises the importance of using targets and supplier scorecards, but less is described on how many companies are actually able to do this today.

3 Methodology and Cases

In order to explore how front-runner companies use environmental KPIs for their suppliers, front-runners first had to be identified. This chapter explains the methodology used to select and evaluate the front-runner companies studied in this thesis. Each selected company is also briefly explained to provide an understanding of their current situation with respect to company size, business sector, and how many of its suppliers that are currently reporting, to mention a few.

3.1 Selecting the Companies

The first step to select which front-runner companies to include in this thesis was to collect a large number of potential front-runners. This was done by finding companies that are ranked as leaders on the sustainability indices Dow Jones Sustainability Index and/or FTSE4Good Index between September and October 2010. Companies ranking among the top 20 in Folksam's "Index för ansvarsfullt företagande 2009" were also included. These indices do not cover all potential front-runners since all companies are not publicly owned or registered at Dow Jones, FTSE or NASDAQ OMX Stockholm. Just because a company is not a leader in Dow Jones Sustainability Index and/or FTSE4Good Index does not mean that sustainability is not well-developed at the company. Personal recommendations of companies by people with high experience of sustainability reporting and corporate sustainability were therefore included as well. In the end over 100 company names were gathered.

The second step was to screen all these companies with respect to if they used environmental KPIs for their suppliers or not. The screening process was done by assessing publicly available material through the analysing matrix found in appendix A. The publicly available material used was annual reports, sustainability/environmental/ CSR reports, corporate websites, and membership in relevant organisations (e.g. Carbon Disclosure Project's Supply Chain program). Since companies do not necessarily market all aspects of their sustainability work there was a risk that the analysing matrix did not provide a truthful assessment of all companies. If a company was personally recommended it could therefore pass the screening process, even though the company might not have scored well in the analysing matrix. In the end the number of companies was boiled down to 38 companies.

The third step was then to contact the companies and verify if they used environmental KPIs for their supply-chain. They were also asked if they would like to participate in a study where their environmental KPIs would be studied in greater detail. 22 of the 38 companies replied (~58 % response frequency). Five of these companies agreed to participate in the study. The reason why the number was not higher than five was due to a number of limiting factors. The most frequent reason (10 of 22) was that the company did not use environmental KPIs for its suppliers or that KPIs were used for other environmental aspects (e.g. ISO 14001 certification), but not for the production processes. The second most frequent reason (5 of 22) was that the company did not have

time to be interviewed within the timeframe of the thesis. Two companies also declined to participate without specifying any reasons.

3.2 Evaluating the Selected Companies

The five selected companies were qualitatively analysed based on four parameters, related to research questions 1 and 2:

1. **Selection of KPIs:** Which environmental KPIs does the company use? Which environmental aspects do they cover? How and why were they selected?
2. **Implementing the KPIs:** What strategy has the company used to implement the KPIs at its suppliers?
3. **Data collection:** Which method does the company use to collect data for the KPIs? How often do the suppliers report and how is the quality of the data verified?
4. **Improving the supplier performance:** What actions does the company take in order to improve the supplier performance of the KPIs?

Two research methods were used for this qualitative analysis. The first method was a questionnaire sent to the companies where each company filled in basic information about their KPIs. This information concerned aspects such as type of KPI, how the KPIs were calculated, how far upstream in the supply-chain did the KPIs cover, related targets, and which environmental aspects the company's suppliers report on. The different categories were largely based on the recommendations by Neely *et al.* (1997). For more information about how the questionnaire was structured, see appendix B. The questionnaire provided an overview of all the KPIs and served as a foundation for the next step – an in-depth interview. This was conducted either in person or over phone, and lasted about 1h for each company. Since it was hard to know on beforehand which of the analysing parameters a specific company had most experience of, the interviews were semi-structured. This meant that the interview questions and topics were set but the interviewees were allowed to develop their own thoughts within the discussed topics, making the interviews more flexible (Denscombe, 1998). Any additional information that was needed after the interviews were conducted was gathered through short complementary interviews over the phone, or email correspondence. A full list of the interview questions can be found in appendix C. If an answer to one of the questions could be retrieved from a company's website or annual/sustainability/environmental/CSR reports, these sources were used instead of asking questions during the interviews.

Some important notes about the interviews have to be made. Due to the semi-structured approach of the interviews all of the interview questions were not raised during the interviews. If a company is not mentioned in a context in "Analysis and findings" it should therefore not be interpreted as that the company does not do anything within that context, unless otherwise stated. Another important note is that the focus of the interviews was on the actual work that the companies did. The focus was therefore not on why a company does not e.g. track a certain environmental aspect for its supply-chain.

Some topics, like the implementation of the KPIs, were something that developed as the interviews progressed. These were first not intended to be included in the scope of the thesis. In appendix C there are therefore not questions about all featured findings.

3.3 Case Studies

The five companies that were interviewed are briefly described here along with who was interviewed and a short overview of the companies' use of environmental KPIs for their suppliers. All five companies are major multinational corporations with an integrated approach to sustainability, i.e. it is integrated into all relevant business processes (e.g. purchasing). The classification of the industry sectors is done according to the Industry Structure and Definitions by the Industry Classification Benchmark (ICB, 2011).

3.3.1 Company A

Company A is a Nordic company within the industrial engineering sector. Its Director of Corporate Sustainability was interviewed in this study. This person is responsible for the company's approach to sustainability and develops the strategies which are integrated into all major business processes. Parts of the company's production are outsourced, although the majority is in-house. Since 2007 the company has required its suppliers to report on their energy use and greenhouse gas emissions. In the beginning the company required that about 200 (major) 1st tier suppliers out of 10 000 in total must report on these areas. After joining Carbon Disclosure Project's Supply Chain program in 2008 and leaving the year after, the number of suppliers was changed to about 40. These 40 suppliers are the most energy intensive of the company's suppliers.

3.3.2 Company B

Company B is a Nordic company within the technology hardware and equipment sector. For this study one of three Sustainability Managers within the company's sustainability sourcing team was interviewed. The person is responsible for sustainability KPIs for suppliers. The company both has in-house production as well as outsourced production. Since about 2007 the company has been using environmental KPIs for its 1st tier suppliers, which report on energy use, greenhouse gas emission, waste handling, and water use. In the beginning it was only required by a small group of the company's about 150 hardware suppliers to report this data. By time this group has expanded, and still is, and today it includes about 100 suppliers. Some of these are only encouraged to report while suppliers which are strategically important or have a high environmental impact are required to report. The suppliers are located in every part of the world.

3.3.3 Company C

Company C is a Nordic company within the general retailers sector. At the company three people where simultaneously interviewed; a CSR Controller, an Auditor, and an Environmental Performance Analyst with responsibility of analysing the environmental KPIs for the supply-chain. All of the company's production is outsourced, mostly to Asia. The company has since 2006 tracked the water quality and raw material handling of its 1st

tier suppliers. In 2008 the scope for water was extended to include water consumption and efficiency as well. The water reporting is part of its Code of Conduct and therefore all the suppliers must report on the water KPIs. As of 2010 the company has an ongoing pilot study to extend the scope of its environmental reporting to include energy use and greenhouse gas emission as well. Of the company's major 1st tier suppliers, about 100-120 participate in the pilot project. These represent all major production markets and a large share of the company's total production. The aim of the pilot study is to have enough data in 2011 to set targets starting 2012. The next step is to increase the number of 1st tier suppliers which report on their energy use and GHG emission.

3.3.4 Company D

Company D is a Nordic company within the household goods and home construction sector (alt. powered home appliances). The company has both in-house and outsourced production. At the company the Director of Responsible Sourcing was interviewed. The person is responsible for controlling and developing the suppliers with respect to the company's Code of Conduct. Altogether the company has about 3,500 1st tier suppliers. Since 2010 the company has an ongoing pilot study concerning energy use for six major 1st tier suppliers that are located in China. This pilot study will be expanded during 2011 by including more suppliers.

3.3.5 Company E

Company E is a Japanese company within the automobiles and parts sector. Two representatives from the European division were interviewed. They worked as Manager and Environmental Expert, respectively, at the European environmental and safety planning office. The Manager had a coordinating function while the Environmental Expert collected, analysed, and provided feedback on the environmental KPI data from both in-house factories and suppliers. Since about 2007 the company has conducted a pilot study for its major 1st tier suppliers to report on greenhouse gas emission, waste handling, and water use. The ambition of the pilot study has been to learn which KPIs to use and which targets to set. The company is currently re-writing its purchasing guidelines and will commence implementing the environmental KPIs into the normal business operations during this year.

4 Analysis and Findings

The findings from the case studies are divided into five sections. First the different environmental aspects that the companies' suppliers report on are described. The second section describes which KPIs the companies use for this reporting. It also describes the reporting standards that the companies use as well as challenges they have experienced with their selected KPIs. The third section describes the strategies the companies use to implement the KPIs at their suppliers. In the fourth section the data collection for the KPIs is explained. Focus lies on which method the companies use to collect data, how often the KPIs are reported, and how the companies verify that the reported data is correct. The fifth and last section details what actions the companies take in order to improve the performance of the KPIs.

4.1 Reported Environmental Aspects in the Supply-chain

The environmental categories which the companies track differed, as well as the environmental aspects within these categories. Companies A and D only tracked energy use and greenhouse gas emission, while companies B, C, and E tracked several categories. No company tracked all four categories for their suppliers. For a full overview of the reported categories and their environmental aspects, see table 4.1. An important note is that an environmental aspect does not necessarily translate into a KPI, although this is often the case. The energy sources are for example incorporated into the energy and GHG emission KPIs. For further details about which KPIs are used, see section "4.2 Used KPIs".

Apart from energy use and greenhouse gas emission there is little homogeneity within each category on which environmental aspects should be reported on by the suppliers. The most frequent reported category is energy use and greenhouse gas emission, which is tracked by all companies. Water use ranks second, followed by waste handling and raw material handling. Most efforts therefore seem to be placed on managing energy, greenhouse gas, and water issues in the supply-chain, while less effort is taken to manage raw material and waste issues.

4.1.1 Energy Use and Greenhouse Gas Emission

As can be seen in table 4.1, in principle all of the companies track both the suppliers' greenhouse gas emissions and energy use. The only exceptions are company D, which does not track the greenhouse gas emission, and company E, which does not track the amount of used energy by the suppliers. Both companies do however have all the necessary data to determine these since the suppliers report on each used energy source. All companies also tracked all energy sources used by their suppliers, except company B which only tracked the use of electricity. Although company D does not have any KPIs for GHG emission, it does calculate the GHG emission for each supplier. However, this data is only used internally, and not communicated to the suppliers. The reason is that the company first wants to make sure that the energy use KPIs are up and running, and that

actions to reduce the energy use are in place. Once these things are reached, the company will probably introduce KPIs for GHG emission.

		Company				
Category	**Aspect**	**A**	**B**	**C**	**D**	**E**
Energy use and GHG emission	Amount of energy used	X	X	X	X	
	Amount of CO_2(e) emitted	X	X	X		X
	Used energy sources	X	X	X	X	X
Raw material handling	Amount of sustainable materials			X		
	Type of sustainable materials			X		
Waste handling	Amount of waste		X			X
	Type of waste		X			
	Waste treatment method					X
Water use	Amount used		X	X		X
	Amount recycled		X			
	Water quality			X		
	Used water sources					X

Table 4.1: An overview of which environmental aspects in the supply-chain the companies have KPIs in place and collect data for.

4.1.2 Raw Material Handling

It is only company C that tracks the handling of raw materials of its suppliers. The aspects that are covered are which type of sustainable materials are used (e.g. organic, recycled, and alternative materials) and their respective amounts. Nothing is however reported by the suppliers on the yield of their production processes.

4.1.3 Waste Handling

The two companies that track waste handling have different approaches. While both track the amount of waste that is generated, company B also tracks what type of waste it is (e.g. hazardous/non-hazardous) while company E tracks how the waste is treated (e.g. sent to landfill, incinerated or recycled). Apart from the amount of waste, there is therefore no general approach among the companies on how the suppliers should report on waste issues.

4.1.4 Water Use

The second most reported environmental aspect is water use, which is tracked by three out of five companies. Like waste handling there is no general approach between the companies for how the suppliers should report on this. All the companies track the amount, but then each company also tracks an additional specific area. Company B tracks how much water is recycled in a supplier's factory, company C tracks the water quality (e.g. oxygen level and contained chemicals), and company E tracks which sources the water is withdrawn from (e.g. tap, lake or rain).

4.2 Used KPIs

A large number of KPIs were collected from the companies, especially for energy use and GHG emission since suppliers of all of the companies reported on that category. These KPIs will be described and analysed in the corresponding sub-sections. The original names of the KPIs have been removed and the KPIs are instead categorised according to indicator type. This will make it easier to compare them and visualise patterns. Also, almost no company included any sub-contractors to the 1st tier suppliers in the scope of the KPIs, see figure 4.1.

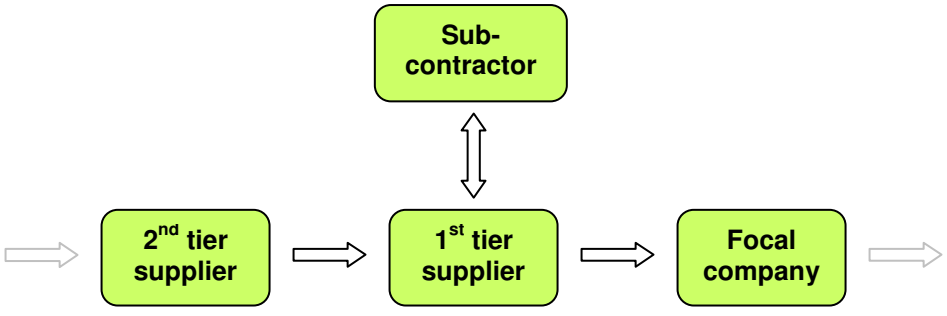

Figure 4.1: Schematic overview of supply-chain with sub-contractor included.

The only exception was company C, where the water KPIs were used for both 1st tier suppliers and their sub-contractors (separate KPIs). The consequence of not including sub-contractors means that a 1st tier supplier that has outsourced a production step to a sub-contractor will seem to have a lower environmental impact, than a completely analogue 1st tier supplier that has all production steps in-house. Company B had started working on how to include the sub-contractors, but could not provide any more details at this stage. Company D said it would become too complex and difficult to manage the KPIs if sub-contractors were included. They proposed that in the meantime 1st tier suppliers with outsourced production could be "flagged" so that consideration could be taken into account when comparing two suppliers.

4.2.1 Energy Use and Greenhouse Gas Emission

As can be seen in table 4.2 there are a lot of similarities between the different companies. Four out of five companies use both absolute and normalised (efficiency) indicators when tracking the energy use and/or GHG emission of their suppliers. The importance of doing this was argued by company A, which said that this was the only way to get a true picture of a supplier's performance. The reason is that a supplier can be very good at managing its energy use and GHG emission and have very efficient production processes. If however the supplier at the same time is growing rapidly, as many suppliers in China do, the absolute amount will increase rapidly as well. If only the absolute amount would have been reported it would seem that the supplier is doing a bad job, when in fact it does not. In a similar way it could be that a supplier is not trying very hard and has very inefficient production processes. If this supplier would get a drop in production volume there would be a decline in absolute energy use and GHG emission. Would only absolute indicators be used in this case the supplier would seem to do a good job, even though it has done little to improve the situation. By using both an absolute and a normalised indicator these kinds of situations are avoided.

Other mentioned advantages of normalised indicators were that they are important for comparing different suppliers and sourcing countries with each other, visualising saving potential for other suppliers (company D), and that they can provide more measured data for Life Cycle Assessments (LCAs) (company B). Company E used its normalised indicator to verify the quality of a supplier's reported data by comparing it with previous years. One can then be tempted to only use a normalised indicator, but as company C stressed: "You want to measure the total amount because of course it is important to become more efficient, but ultimately we are trying to solve some of the world's problems", where the latter is only achieved by reducing the total amount. The importance of measuring both the absolute and a normalised amount is not limited to energy use and GHG emission, and is valid for the other environmental categories as well.

Another similarity between the companies is that they all calculate the absolute GHG emission according to the GHG Protocol (or an analogue method to calculate the energy use). The GHG Protocol recommends that the amount of each used energy source is summarised and then transformed into CO_2(e) (or energy units) using standard factors. All companies track all used energy sources. The only exception is company B which

only tracks the electrical energy use. There is also a similarity for how companies determine the normalised indicators. Companies A and B let their suppliers determine the allocation unit so that it best suits their operations. The three other companies have predetermined allocation units which the suppliers should use. The advantages and disadvantages of these different allocation units and methods are discussed further in sub-section 4.2.6 "Challenges". There it is also described how to calculate the focal company's share and the challenges that are related to it.

		Company				
	Indicator	**A**	**B**	**C**	**D**	**E**
Energy use	**Absolute energy use**	MWh	kWh	GJ	MWh	
	Normalised energy use	MWh per allocation unit	kWh per allocation unit	GJ per 1000 units produced	MWh per standard unit	
	Company's share of absolute energy use		kWh	GJ	Already included in other KPIs[1]	
	Energy cost				Cost per MWh	
GHG emission	**Absolute GHG emission**	Tonnes CO_2(e)	kg CO_2(e)	Tonnes CO_2(e)		
	Normalised GHG emission	Tonnes CO_2(e) per allocation unit	kg CO_2(e) per allocation unit	Tonnes CO_2(e) per 1000 units produced		Million tonnes of CO_2(e) per €
	Company's share of absolute GHG emission		kg CO_2(e)	Tonnes CO_2(e)		

Table 4.2: The KPIs used by the companies within the areas of energy use and greenhouse gas emission. "Per allocation unit" means that it is up to the supplier to determine the normalisation unit, e.g. per product, per revenue, etc. [1]All KPIs for company D are already allocated to the company's part of the supplier's production.

One approach which is unique to company D is to measure the cost of the energy use. This is calculated by dividing the total energy cost (in local currency) with the absolute

energy use (in energy units). According to company D this indicator has several advantages. First of all it visualises the cost savings that a supplier has made or can make through energy efficiency. The suppliers (and the company) can therefore easily see the fruit of their efforts. Secondly, the KPI is very easy to communicate to the suppliers, internally within the company, and to stakeholders since it is directly translated into a cost (i.e. money). The third advantage is that it gives the company a more complete picture of all related costs when moving production from a high-cost to a low-cost country. A drawback if it is going to be used for other environmental aspects is that all of these are not possible to translate into a cost, e.g. water quality.

Overall, the level of the reporting is very high for all companies since most measure the absolute as well as a normalised amount for their suppliers' energy use and/or GHG emission. All the companies, except company B, also include all the different energy sources in the reporting, which makes the reporting very extensive. Simply looking at the KPI portfolio it is hard to select one company that stands out since companies A-D all have an overall high level, and their different approaches complement each other. Company E on the other hand only has a normalised indicator, which can make it harder to reach absolute reductions.

4.2.2 Raw Material Handling

Since it is only company C that tracks the raw material handling of its suppliers, it is impossible to compare different approaches and find patterns. However, the company's approach can still be described. See table 4.3 for a list of its KPIs. The company has divided the material types into three categories: organic, recycled, and alternative material. This allows the company to track materials with a production process that has a lower environmental impact. It can also track materials with a lower need to produce more virgin material. The approach is therefore more descriptive than just having a single generalised KPI on "environmentally friendly materials". Many of the KPIs are quite industry-specific, making it hard to apply them to other industries. However, recycled material can be used for all, but it needs to be more specific to be useful, e.g. recycled steel or recycled plastic (or even more specific).

Indicator	Company C
Organic material	Tonnes (and share of absolute amount of all used materials)
Recycled material	Tonnes (and share of absolute amount of all used materials)
Alternative material	Tonnes (and share of absolute amount of all used materials)

Table 4.3: Raw material handling KPIs used by company C.

4.2.3 Waste Handling

As previously noted, companies B and E track waste handling using two different approaches. Which KPIs they use to track can be seen in table 4.4. Company B measures the absolute and a normalised amount of the hazardous and non-hazardous waste that is generated by each supplier. It also measures the company's share of the absolute amount. The classification of hazardous and non-hazardous waste depends on local legislation and is not defined by company B. In contrast to company B the KPIs of company E measure the absolute amount of waste that is processed by four specific waste treatment methods: energy recovery, incineration, landfill, and recycling. This division allows the company to keep track of where the waste is sent by the suppliers. There are two reasons to why the company has this KPI. The first is as a corporate social responsibility to avoid that waste generated by the company's activities (incl. suppliers) ends up at a landfill and thereby encourages the use of landfills. The second reason is that landfills will either be banned or not remain free of charge in Europe and Japan. There is therefore also an economic incentive for not sending waste to landfills.

	Company	
Indicator	**B**	**E**
Absolute amount of hazardous waste	kg	
Absolute amount of non-hazardous waste	kg	
Absolute amount of waste per waste treatment method		Million tonnes
Normalised amount of hazardous waste	kg per allocation unit	
Normalised amount of non-hazardous waste	kg per allocation unit	
Company's share of absolute amount of hazardous waste	kg per allocation unit	
Company's share of absolute amount of non-hazardous waste	kg per allocation unit	

Table 4.4: Waste handling KPIs used by the companies B and E.

Although the two approaches are fundamentally different, there are some similarities since both companies track the absolute amount of waste that is generated. The two also complement each other since company B tracks what type of waste is generated, while

company E tracks how the generated waste is taken care of. An additional aspect of company B's approach, which company E lacks, is the ability to determine the waste efficiency. This is similar to measuring the yield, since the less waste that is produced, the more material is incorporated into the products (as long as the amount of purchased material remains the same).

4.2.4 Water Use

Being the second most reported environmental category, several KPIs on water use were collected from companies B, C, and E. These KPIs can be seen in table 4.5. Similar to the KPIs for energy use and GHG emission, the majority of the companies track using both an absolute and a normalised indicator for the water use. The same types of arguments for why it is important to measure both types are valid here as well. Compared to the energy use and GHG emission KPIs, the number of water sources which are reported on by the suppliers is less extensive. Company E is the only company that requires its suppliers to report from what sources the water is withdrawn, e.g. lake, river or tap. Although several water sources could be reported on, the interviewees only had experience of tap water. The reason is that only tap water is used for their European operations since the infrastructure in Europe is well-developed. As they were responsible for the European operations, they did not have insight into other parts of the world.

	Company		
Indicator	**B**	**C**	**E**
Absolute water use	m^3	m^3	m^3
Normalised water use	m^3 per allocation unit	litres per kg of production	
Absolute amount of recycled water	m^3		
Water quality of discharged water		BOD, COD, TSS, and colour	
Company's share of absolute water use	m^3		

Table 4.5: Water use KPIs used by companies B, C, and E. BOD is Biological Oxygen Demand, COD is Chemical Oxygen Demand, and TSS is Total Suspended Solids.

The two other companies measured the absolute water use in two different ways. Company B measured it as the amount of water that is withdrawn from the tap while company C measured it through a meter in the suppliers' effluent water treatment plants. There is therefore a lack of consensus on how to measure "used water".

Company B is the only company that measures the recycling rate of the water consumption, i.e. the amount of water that is re-used in the supplier factories. The amount of discharged water is thus the difference between the absolute water consumption and the amount of water that is recycled. A problem with company B's set of KPIs is that the water quality of the discharged water is not measured, meaning that there is no control if pollutants are high enough to affect the eco-system. On the other hand company B has a KPI in place that tracks the ISO 14001 certification status of the company's suppliers. It is therefore indirectly checked that the discharged water does not harm the environment. The water quality is however measured by company C which measures it using four categories with specific threshold values that the water must not exceed. These categories are:

- Biological oxygen demand
- Chemical oxygen demand (corresponds to amount of organic pollutants)
- Total suspended solids
- Colour

These four categories cover a substantial part of the impact on the water quality caused by the production processes of company C's suppliers.

A problem the companies have with their water reporting is that they do not cover the aspect of vaporized water. The amount of discharged water for company B could be measured by the difference between the absolute consumed water and the recycling rate. If a lot of water is vaporized then the amount of water that is discharged will be lower than this difference. However, company B does not track the amount of discharge water and is not facing requests from suppliers and stakeholders to start doing it. Consequently this has not been considered as a problem, but the company will discuss the issue next time the KPIs are reviewed. The issue of vaporized water is larger for company C which measures the water consumption in the effluent treatment plant, i.e. the water that is measured is the amount of discharged water. This means that the KPI for water consumption to some degree is misleading. If a lot of water is vaporized during the production processes or embedded into the products, the actual environmental impact of the water use at a supplier is larger than what is measured by the KPI. This problem is of even more importance since some of company C's suppliers are situated in water scarce areas.

Although some similarities exist between how the companies track water use, there is an overall lack of consensus on how the suppliers should report, and none of the companies used the WFAM for classifying and calculating the water use.

4.2.5 View on Reporting Standards

Overall, the companies are positive towards global standards on how to report on environmental aspects, both for their own production and for the supply-chain. One advantage of common standards is that the vocabulary will be the same, meaning more transparency and less risk of misinterpretation. It also provides more transparency towards the public (company E). By reporting according to a common standard there is

less risk that companies develop their own reporting standards. If every company has its own standard it becomes impossible for a company to compare its performance against other companies (company D). If companies use common standards for how their suppliers should report, the suppliers would only have to use one reporting standard for each environmental category. This means that the workload of the supplier becomes smaller. The risk of developing supplier fatigue will therefore be smaller (companies B, C, and E). As an example, company E mentioned that it had previously used its own standard to track which chemicals are used in its materials. This was not compliant with the standard used by all other companies within the same industry. As a consequence the company's suppliers complained. Company E therefore adapted to the common standard instead of continuing with its own.

A disadvantage of common standards is that there currently are not standards available for all environmental areas (company B). Another disadvantage is that such standards can become a bit too theoretical and academic, and less practical in order to be valid for all types of industries (company D). The company had however not experienced the GHG Protocol to be much like this. The GHG Protocol is the only standard used by the companies within the scope of this thesis and is more or less used by all the interviewed companies (company D has an internal standard which is very much inspired by the GHG Protocol). The high use of the GHG Protocol can be seen by how similar the companies' KPIs for energy use and GHG emission are.

There is a large interest among the companies for standards within these areas as they allow the reporting to be more uniform.

4.2.6 Challenges

Three main challenges associated with the KPIs were identified by the interviewed companies:

- How to allocate the normalised indicators
- How to allocate the company's share of the suppliers' environmental impact
- How to select the KPIs for a wide and deep supply-chain

As explained in sub-section 4.2.1 "Energy use and greenhouse gas emission" the companies either let the supplier determine the allocation unit for the normalised indicators (companies A and B) or have predetermined allocation factors (companies C-E). The predetermined allocation units were "per 1 000 units produced" or "per kg of production" (company C), "per standard units" (company D) or "per €" (company E). The experienced advantage of letting the supplier determine the allocation unit is that the allocation will be relevant for the specific production process of a supplier. The drawback is that it becomes impossible to compare suppliers that use different allocation units. Although company C currently uses fixed allocation units for its energy and water use KPIs, they are just used to acquire a baseline to set targets from. In reality the company will develop a variety of allocation units for each environmental aspect. The one that will be used by a supplier will be the one which is most suitable for its operations. In other

words it will be very similar to the approach of letting the supplier itself determine the allocation unit.

According to company E, the advantage of allocating the total turnover using € is that it makes it possible to compare data reported by a supplier over the years. This makes it easier to verify the data quality and see any possible deviations. The suppliers still cannot be compared to each other since the production processes differ too much in order to make the comparison fair. This drawback is also valid if per units produced, kg or something similar is used, since these allocation units do not say anything about the production process itself. The companies therefore experienced it as a challenge to select the allocation units in order to compare the suppliers, e.g. to evaluate saving potential or which supplier to source from. The latter was however not experienced as a problem for company B. The reason is that its suppliers are ranked through its supplier scorecard where other aspects than just the efficiencies are taken into account. The company pointed out another problem which was related to the company's use of normalised indicators to get more measured data for its LCAs. The problem is that the same supplier can manufacture products and components of different types, complexity, and size, e.g. batteries and cameras. This causes the normalised KPIs to be a mixture of several products with different resource requirements for their manufacturing processes. One example is that the normalised energy use is not true for how much energy is needed to produce one specific product, which is the idea of LCAs.

The last company (D) has solved its allocation problems by letting each product correspond to a certain number of standard units, making the KPI more of an indexed indicator than a normalised one. The larger and more complex the product is the more standard units will it correspond to. A battery might for example be 1 standard unit while a camera could be 1,000 standard units (these are just examples and do not represent the company's suppliers' production). This allows the company to compare the efficiency and saving potential of different suppliers, provided that their production processes are comparable. Previously, the company allocated by an "added value". Since it varied with economic fluctuations and different standards in different countries, the company chose to use standard units instead. The standard unit is not limited to the environmental reporting and is used throughout the company for other purposes as well, e.g. financial data. How easy it was for a supplier to adopt the use of standard units depended on how experienced the supplier was with energy reporting. The suppliers which were experienced had no problem adopting it, while suppliers which were more in a beginner stage needed additional training by the company.

The second main challenge experienced by the companies was how to allocate for the company's share of a supplier's production. The companies would like to use a supplier's total production volume or turnover together with the company's corresponding share. However, this information is sensitive to a supplier since it contains information about its buyers – buyers that could be competitors to one another. Companies D and E have tried to work around the problem by letting the supplier do the estimation themselves and then provide the company with its respective share of e.g. the absolute energy use. In this way a supplier's total turnover or production volume is not revealed to its focal companies.

The drawback is that the companies cannot verify if the provided data is correct. The only means the companies have to do this is to control if the estimation method is correct or not. How to actually guarantee that the provided information is correct is experienced as a difficult task (company D). In the best of worlds, company D would like each supplier to have a dedicated production line together with an energy or water meter. Company E also had an additional approach to solve the problem – an approach it shared with company C. The approach is that the suppliers provide the company with a percentage of how much of the supplier's production the company corresponded to. Company E had not experienced any additional drawbacks of this method. The suppliers of company C were however a bit reluctant to share this information. Since each focal company knows how much it has ordered, it is possible for them to calculate backwards and get the total production volume or turnover.

To examine how the company's share differed by allocating total turnover or production volume, company B told some of its suppliers to report using both ways. The result was that the company's share differed a lot if per product or per revenue was used. This makes the selection of the allocation unit even more problematic. It also makes it hard to compare the company's footprint from different suppliers. Company D comes up with individual solutions for each supplier, but is interested to see how other companies are doing it in order to make the allocation more uniform for all companies. This will improve the comparability and decrease the workload of the suppliers since they can use the same method for all of their focal companies. Company C also thinks it is a challenge to allocate the company's share, but thinks the problem is of less importance. The reason is that a KPI for the company's share will not help the company to reach its business objectives. The KPI is also only one data point amongst many. As long as the other KPIs are working, having a non-perfect allocation for the company's share is a problem the company can live with.

A third challenge was experienced by company B. Not only is its supply-chain rather deep with 4-8 suppliers between the raw material extraction and the company's own factories, it is also quite wide with a large group of suppliers that the company works directly with. The company thus finds it hard to "select the KPIs in such a way that they apply for all suppliers, although they are quite different, and give enough guidance to the suppliers, but still they need to be on a general level but at the same time be detailed enough to support the supplier." Due to time-limitations this subject was not discussed with any other company.

4.3 Implementing the KPIs

After having selected which KPIs to use, they must be implemented at the suppliers. One strategy mentioned by company B-E was to first conduct a pilot study in order to learn how the KPIs work and how to engage the suppliers on the matter before the KPIs are officially integrated into the business. Apart from receiving training on how to measure and report the KPIs, companies B-D also included additional support to help the supplier and ease up the implementation. Company D described it as: "we really want the supplier to also see the value of participating in this, why it is done, and why one should commit

to it. We then decided to make the pilot project a little bigger and more extensive than just the reporting of data" and by doing so "in some way guarantee that the suppliers catch the big elephants and do not shoot at the ants." In order to guarantee this, the company has organised workshop-structured meetings. Here the suppliers meet, exchange experiences on how to solve problems, and receive training from energy experts on how to save energy in their factories and other energy-related aspects. The workshops are experienced to be very fruitful and the suppliers can in many ways provide solutions to each others problems. An aspect the company has identified as being important is to help the suppliers to go from theory to practice. The company's suppliers are therefore offered energy audits, where solutions to improve the energy efficiency are pointed out on the factory floor. This has been very appreciated by the suppliers. The energy audits are free for both the suppliers and the company as they are financed by local authorities in China which support projects for energy efficiency. The role of the company has therefore been mainly to establish the contact. The supplier itself decides if and which of the suggested energy improvements should be implemented. As with the energy audit there are possibilities to get improvements financed by local authorities. With time the pilot project will expand to cover more and more suppliers. The general response company D has, is that suppliers are eager to learn and grateful that the company shares its knowledge with them.

Company B is not in a pilot stage, but whenever it introduces a new KPI it first conducts a pilot to test the KPI before it is integrated into the system. For the pilots it arranges workshops similar to those of company D. The suppliers also give feedback on how the KPIs work in order to improve them. How the groups are composed varies from component-specific (both very experienced and not so experienced suppliers) to suppliers which have experienced the same problem. The company emphasises the importance of knowing each supplier's experience-level in order to get the right group dynamics. The company feels that the need of workshops decreases the more the suppliers report and become experienced. Back in 2007 when the company started using environmental KPIs it started with a small group of suppliers. The group has over the years expanded step-by-step up to today's roughly 100 reporting suppliers.

The pilot project of company C encompasses 100-120 of its major 1st tier suppliers and can be seen as one very large pilot project, or very many small ones. The reason is that the pilot project consists of several local programs all over the world. Each program is set up by an external local service provider, e.g. a consultancy company or an NGO. Company C therefore does not run the pilots per se. Instead it sets up the partnerships for the projects and has a global EHS coordinator that makes sure that all programs have similar content and that they achieve what company C wants them to achieve. The design of each program is up to the service provider. For every supplier each program must however have training on energy issues by experts, free energy audits, and the creation and follow-up of action plans. The objective of these programs is to build up an in-house knowledge within each supplier. The programs run for about 6-12 months. The suppliers then have their action plans to follow and company C can track if the desired development is reached through its KPIs. The company will also set targets, but more on that in section 4.5 "Improving the supplier performance". The next step of the pilot study

is to incorporate all of the non-major suppliers as well. The result of this large pilot project is too soon to tell since it is still running. So far the reception of the programs has been good. The suppliers see it as a way to reduce costs and improve their production efficiency. They are also thankful for the help that they receive from company C.

In contrast, company A seemed to not have run a similar pilot project when it implemented its energy use and greenhouse gas emission KPIs. It started with its major suppliers (about 100-200) and required them to report. Some of the suppliers seemed to not have any understanding on the issue and the company struggled with a poor reporting quality. After joining the Carbon Disclosure Project's supply chain program for a year without much improvement of the situation, the company narrowed its scope to only include its energy-intensive suppliers (about 40). This made the KPIs easier to manage and the quality became higher.

Several approaches therefore exist amongst the companies on how to implement the KPIs, but a general trend is to first provide an extensive pilot where the suppliers receive both theoretical and practical support in order to gain a high compliance rate before they are integrated into the normal business.

4.4 Collecting Data for the KPIs

After having selected and implemented the KPIs it is important to have a working process of collecting data for the KPIs from the suppliers. In this section it will be explained which collection method the companies use. It will also be explained how often the suppliers report data for the KPIs and how the quality of this data is verified by the companies.

4.4.1 Collection Method

All companies collect data for the KPIs in a completely manual way using predefined Excel sheets. The collection process and how the data is handled within the focal company is also roughly the same in all companies, see figure 4.2 for a schematic overview of this process.

An Excel sheet is sent to each supplier to fill in. This sheet is then sent back to the corresponding purchasing/sourcing team (or similar) at the focal company, where it is collected by a quality/technology/environmental responsible (or similar). This person screens the data and checks if everything seems to be in order. It is then passed on to a sustainability team which manages the data. The only exceptions to this approach are the water use and raw material handling KPIs of company C. The water use KPIs are collected during the yearly Code of Conduct audits. The auditor retrieves the necessary data from e.g. water meters and lab test results and reports it into an internal system. The data is then managed by the sustainability team. The raw material handling KPIs are tracked through a 3rd party control organisation using certified 3rd party labels for classifying the materials. The data is then sent to the sustainability team which manages it.

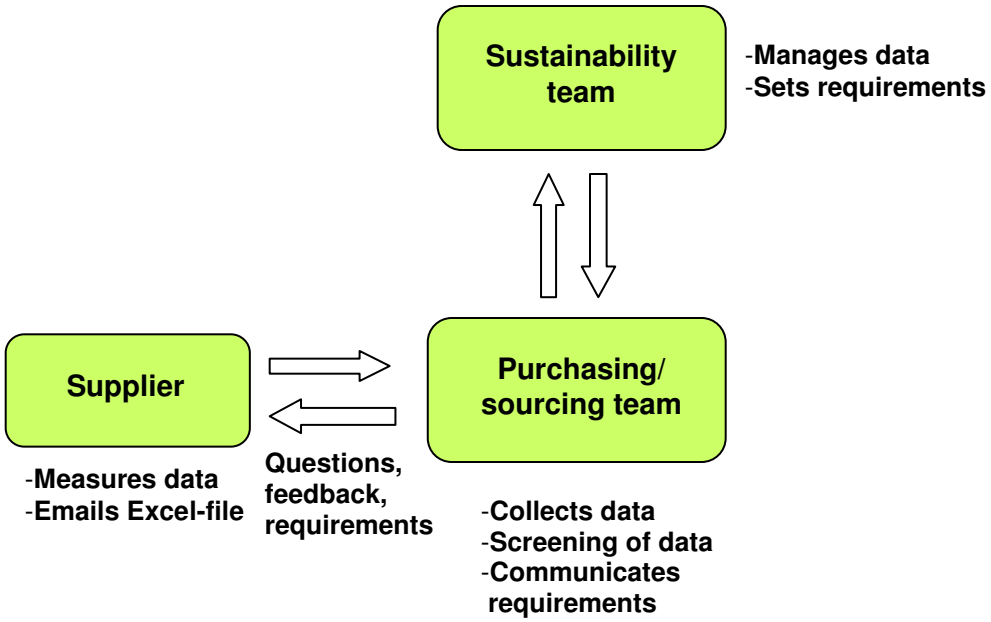

Figure 4.2: Schematic overview of how the companies collect data for the KPIs from their suppliers.

The companies experience the overall collection process as a heavy workload both for the suppliers and for themselves. According to company D this is not sustainable in the long run with an increasing reporting frequency and a larger amount of included suppliers. All companies therefore expressed a desire to move towards a software-based tool instead in order to improve the overall process and reduce the workload; both internally and for the suppliers. Companies B and C want a tool that could cover all tracked environmental areas. It should also cover other sustainability areas that are tracked by the companies. With such a tool companies B, C, D, and E could increase the reporting frequency. For company E it would at least be an increase from annually to quarterly, but preferably monthly. Such a high reporting frequency is not possible today for the companies since the workload would be too great using the manual data collection. Company E would use this higher reporting frequency to implement a Plan-Do-Check-Act (PDCA) methodology for its suppliers. In a similar way company C wants the system to not only streamline the overall process, but also allow for better analysis, visualisation, and communication of the KPIs.

Luckily, there are such reporting tools available on the market. Company C is for example currently on its way of implementing such a tool. This specific tool is able to handle all of the company's current tracked environmental aspects. Likewise, company E is developing its own reporting tool together with a few consultant companies using cloud computing. This tool would be used for the in-house production as well as for the suppliers. Further details about his tool were not available since its development is managed at another office.

Instead of finding a reporting tool on the market, company A wants to implement the KPI reporting of its suppliers into its existing internal reporting tool. This tool is used for the company's factories all over the world. The tool gathers and verifies data through a web-based system and is according to company A well-developed and quite advanced. What limits the company from implementing it is that the reporting process for suppliers is not stable and mature enough for it to be implemented. Currently the company would have to come back every year and make adjustments if the suppliers were to be integrated. It would also involve a large adjustment of the system to incorporate that many new companies (i.e. the suppliers). These two aspects make it too complex and expensive to implement the suppliers in the current situation. When the company feels it has the right questions, the right scope, and a stable process for handling incoming data, the suppliers will be integrated. However, company A cannot say when this will happen.

4.4.2 Reporting Frequency

For companies A and E the KPIs are reported annually by the suppliers, and for company D it is a few times per year. The reporting frequency of company C varies between the different environmental categories. For water use, the KPIs are collected once a year, while the raw material handling KPIs are reported every two months. The energy use and GHG emission KPIs are still in a pilot project, and as the company is still gathering data for the baselines there is no requirement on a certain reporting frequency. The company does however plan to have a quarterly reporting. The reporting frequency also varies for company B. Depending on which supplier it is that reports, the reporting frequency can vary between twice per year to every two months. For a full overview of the reporting frequency, see table 4.6.

	Company				
Reporting frequency	**A**	**B**	**C**	**D**	**E**
Annually	X		X[1]		X
Twice per year		X			
Few times per year		X		X	
Quarterly		X	(X[2])		
Every two months		X	X[3]		

Table 4.6: Reporting frequency for the different companies' suppliers. The reporting frequency differs between environmental categories for company C: [1]water (annually), [2]energy use and GHG emission (quarterly, planned), and [3]raw material (6 times/year). Depending on the supplier, the reporting frequency for company B varies between twice per year to every two months.

There is a clear trend among the companies to have a reporting frequency that is about once or twice per year per year. One exception to this is the raw material handling KPIs of company C that are reported by a 3rd party organisation. Another exception is the company's planned quarterly reporting of the energy use and GHG emission KPIs. The last exception is the suppliers of company B that report more on a more frequent basis than twice per year. The reasons for this variation in reporting frequency was not discussed. However, the company stated that it has some suppliers that have a well-developed management of their environmental impacts.

A reason for the low reporting frequency of the companies is because of the workload, not due to a low ambition. Company A used to have a quarterly reporting for its suppliers but had to change it into annually since the workload was too high for both the suppliers and for the company itself. Companies B, D, and E agrees with the problem and companies B and E stated that they would increase the reporting frequency if they only had a software-based reporting tool to lower the workload. The problem is even clearer when the reporting frequency is compared between the suppliers and the in-house factories of companies A and D, where the latter reports on a monthly basis. The factories are able to report this often thanks to more manpower available to manage the data, as well as a well-integrated internal reporting system (for company A).

An important note to observe while discussing the reporting frequency is that although a high frequency allows for more detailed tracking and faster business decisions, it is hard to say that a company with a higher reporting frequency is "better" than one with a lower. The reason once again has to do with workload. Adding up to the workload is not just the frequency, but also the amount of suppliers that report and how many the KPIs are. It is this total balance that has to be taken into account.

4.4.3 Verifying the Data Quality

The process of verifying the reported KPI data is to a large extent based on trust for all companies. For companies A and C, a reason for this trust is that the participation in the energy pilot study is in the supplier's interest and that the participating suppliers are long-time partners. Besides trust, all companies also provide the suppliers with guidance on how to report and measure. Company B does not think that the problems with reporting quality are due to errors in measuring. Instead, the company experiences that it is due to a lack of communication or misunderstanding. The company will therefore focus even more on training the suppliers during 2011. Company A experienced that many suppliers lacked knowledge on environmental issues when it first requested its suppliers to report on their energy use and GHG emissions. This lack of knowledge caused the reporting quality to be poor. Company D has experienced a lot of sources of error in the suppliers' reporting. To minimize these, the company is emphasizing that its suppliers should document their measurement process so that it is the same procedure every time and if a person leaves another can take over. The supplier should also compare the measured data with previous reports and judge if the development is reasonable or not in order to spot errors before the data is reported to the company. A third advice is to use as many external sources as possible. For example, if a supplier reports its electrical consumption by reading the electricity meter this figure can be double-checked against the electricity

bill. External sources are also used by company C which uses an external laboratory for measuring the water quality of the suppliers.

All companies audit their suppliers. However, it is rarely that a supplier is assessed on how it measures data for the KPIs during this process. The audits are instead usually more focused on social instead of environmental aspects. Neither company A or D control the measurement processes during the audits. However, company D has plans to implement such an aspect during its audits. The auditing process is still very new at company A, but it saw auditing of the measurement process as a possibility once the KPI reporting process was more stable. One company that does control the measurement process is company C. However, it only controls it for the water use KPIs. The only company to check the measurement processes of all KPIs during the audits was company B. However, the company is not able to do it every time a supplier reports its KPIs since the KPIs are reported twice a year while the audits are conducted once per year.

Once the data is received, all the companies review it. The extent of the reviewing process varies between the companies. Companies A and B perform a simple "sanity check" and it is usually easy to spot any errors. As company A described it: "Sometimes you find a factory making relatively small quantities of steel but producing the same carbon emission as Germany every year. Then you know there is something wrong […]" In a similar way company E compares what a supplier has reported over the years, and if there are any suspicious deviations the supplier is contacted. For reviewing the data, companies C and D goes the furthest. Like the other companies, they perform a "sanity check". They also conduct traditional data controlling, where the companies examine the reporting history and trends as well as comparing the different suppliers to one another. The last part is something the other companies do not do since the KPIs for each supplier often differ too much, making a comparison hard, or even impossible. The data controlling is experienced by company D as a lot of work and takes a long time to do. This is also one of the reasons company C is implementing a software tool for its supplier reporting since it would make it easier for them to verify the incoming data.

4.5 Improving the Supplier Performance

So far it has been discussed how to select, implement, and collect data for KPIs, but little on how to actually improve the performance of them. In other words, how do the companies make sure that the environmental impact is not just reported, but actually improved as well? Since the majority of the companies are still in a pilot-phase it is mostly companies A and B that are taking actions to improve the KPI performance. There are of course actions included in the pilot projects to improve the suppliers' performance, but these actions are discussed in section 4.3 "Implementing the KPIs". This section focuses on actions taken when the KPIs have left the pilot phase and are, so to say, "up and running". The identified actions are divided into three categories:

- Targets
- Integration into a supplier scorecard
- Supportive actions

These actions will in turn be discussed in the following sub-sections.

4.5.1 Targets

Of the interviewed companies only B, C, and E had targets in place for their environmental KPIs. A complete overview of these is found in table 4.7.

Company B has supplier-specific targets for its suppliers. The suppliers are not required to have a target for each reported environmental aspect, e.g. amount of water recycled and amount of water used. However, they must have a target within each of the four reported environmental categories: energy use, GHG emission, waste handling, and water use. The type of targets that should be set along with their size are discussed within the sourcing organisation and then agreed on with each supplier. Several target alternatives are proposed to the supplier. Often the targets relate to normalised indicators, as the absolute indicators differ with how much company B (or any other focal company) orders from the supplier. Although the supplier is provided with alternatives, it is the supplier itself that in the end decides which target is set. To avoid that a supplier adopts less ambitious targets, company B has minimum reduction levels for the different KPIs. If the level of cooperation with a supplier is high, company B could also be the one to set the target.

Company C has two targets for its raw material KPIs. The first is an annual 50 % increase of the amount of used organic material in its products until 2013 from 2008. The second is that all material should come from sustainable sources by 2020, e.g. organic or recycled. These targets were not further discussed during the interview as the focus of the interview moved towards energy and water. In these two areas the company does not have any targets. For energy use and GHG emission, targets will be set during 2011 and take effect in 2012 using a 2010 baseline.

Company E has one target for GHG emission and another for waste handling. For GHG emission the target is to reduce the absolute CO_2(e) emission with 10 % by 2020 for the company's entire operations (including its 1st tier suppliers). In order to reach this target the company has set different internal targets. The type and size of these internal targets depend on which entity is discussed within the company's operations. The targets can also be different during different time-intervals until 2020. The reason for this is to compensate for fluctuations in production volumes over the years, and in the end be able to reach the 10 % reduction by 2020. An example of such a target could not be gathered from the interview. The waste target of company E is to have 0 % waste going to landfills, at all times. How easy it is for the suppliers to reach this target varies as the possibilities to for example recycle waste or send it for energy recovery varies in different parts of the world. For Europe, the suppliers have larger possibilities to avoid landfills. What the difficulties are for other parts of the world was impossible for the interviewees to say since they only had access to data from European suppliers.

	Company				
Category	**A**	**B**	**C**	**D**	**E**
Energy use	No	Supplier-specific	No	No	
GHG emission	No	Supplier-specific	No		10 % reduction in total amount of CO_2(e) from company operations by 2020 (2008 baseline)
Raw material handling			All material from sustainable sources by 2020 & Annual 50 % increase in amount of used organic material until 2013		
Waste handling		Supplier-specific			0 % of waste going to landfills
Water use		Supplier-specific	No		

Table 4.7: Summary of the targets set out by the companies. Company B sets individual targets for each supplier. A "no" means that the company does not have any target, while an empty cell means that the company does not report on any environmental aspect in that category.

The last company (A) has not set any targets since it is having a hard time to determine which targets that are the most meaningful to set – not only how to achieve them but how to actually define them. As an example the company has an internal target to annually reduce its greenhouse gas emissions by 5 % in absolute terms. The advantage of such a target is that it is absolute and therefore addresses the climate change. The drawback is that it is sensitive to fluctuations in production volume. Due to the financial crisis the company had a massive drop in its internal greenhouse gas emissions during 2010. It can therefore seem as though the company has improved its environmental performance drastically. However, it was caused by a huge drop in production volumes. At the same time a supplier could have improved its energy management considerably. If the supplier simultaneously is growing rapidly, the improved energy performance will be masked as

the overall emissions go up due to increased production volumes. Another drawback is that the company has a lot of suppliers in China, where it is not possible to buy green energy. Carbon offsets would be seen as an additional cost and would either be rejected or included in the price. This makes it impossible for company A to reduce the greenhouse gas emissions of its suppliers by any other means than to lower the total amount of used energy, which in turn is impossible since the suppliers are growing rapidly. An alternative would then be to set targets related to normalised KPIs, for example decrease the energy use per ton from 50 MWh per ton to 30 MWh per ton. Company A was however concerned that this does not necessarily cause a decrease in the absolute emissions.

Another aspect that company A is concerned about is that part of the energy demand is in principle independent of the production volume. Company A calls this specific energy demand "background energy". For example, certain supportive systems for the production process have a minimum energy demand, whether 10 or 10,000 units are produced. An example of such supportive systems is pumping systems. See figure 4.3 for an illustration of background energy.

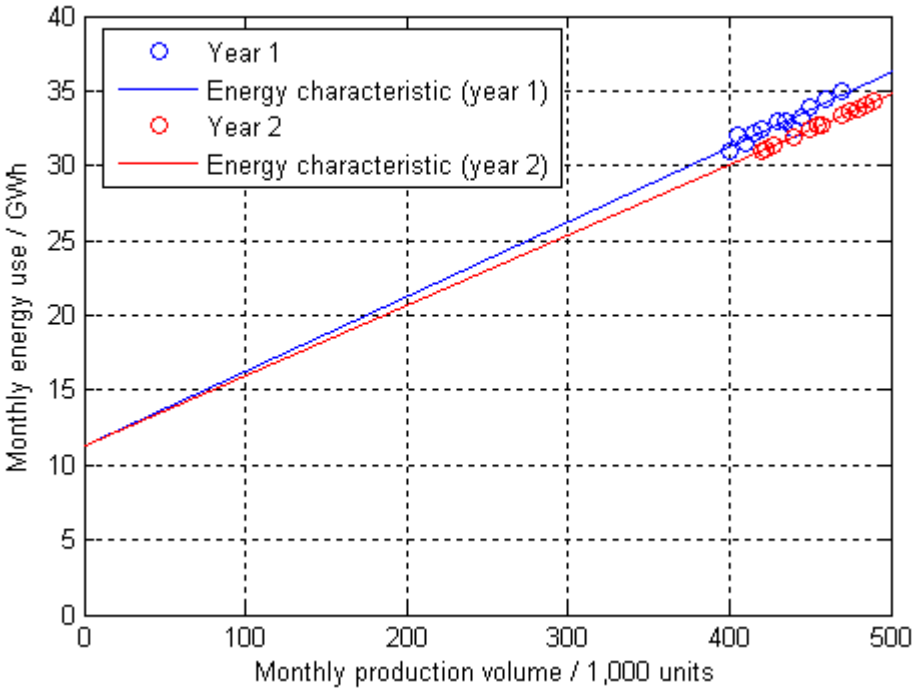

Figure 4.3: The concept of background energy. The monthly energy use is plotted against the monthly production volume. Using linear regression, the 12 data points of a year are used to determine the energy characteristic for that year. The background energy is determined by the intersection with the *y*-axis. Next year's data points are then compared towards the previous energy characteristic to see how the background energy and energy efficiency have changed. (The graph is based on data provided by company A. The data has been modified to lower the risk of backtracking.)

As can be seen in figure 4.3 the absolute energy use is not zero when the production volume is zero. Instead, it intersects the *y*-axis at about 11 GWh. This constant value is the background energy. To measure the background energy of a specific factory, company A is using a technique called monitoring and targeting. The energy use is tracked on a monthly basis. Using linear regression (Blom *et al*., 2005), the 12 data points are used to determine the energy characteristic of that year. The KPI performance is determined by comparing the KPI data with the previous year's energy characteristic. In figure 4.3, the energy efficiency has improved from year 1 to year 2 since the slope of the energy characteristic has decreased. The background energy is however unaffected, since the intersection remains unchanged. Company A is still in the implementation phase to use monitoring and targeting for its own factories. It is therefore questionable if it is efficient to try and implement it at its suppliers, as they often do not have the same type of expertise as the company itself.

4.5.2 Integration into a Supplier Scorecard

Only companies B and C had integrated environmental KPIs into the supplier scorecard. The reason why companies D and E had not done this was that they were still in the pilot phase of their environmental KPIs. Company A first wanted the reporting process to stabilise before the KPIs were integrated into a supplier scorecard. An overview of which companies that have integrated their environmental KPIs into a supplier scorecard is found in table 4.8.

	Company				
	A	**B**	**C**	**D**	**E**
Integration into scorecard	No	Yes	Yes (water use)	No	No

Table 4.8: An overview of which companies have integrated the KPIs into a supplier scorecard.

The fact that few of the companies currently have integrated the environmental KPIs into a scorecard does not mean that they did not see it as important. In fact, the importance was stressed by companies A and D which have plans to integrate them in the future. Company A went as far as saying: "If we don't have a connection between the performance of the environmental KPIs and some real business consequences for suppliers, then it is a waste of time, and everyone knows that."

The water use KPIs of company C is integrated into its Code of Conduct system. In it, a supplier receives a grading based on its performance in social and environmental aspects. How the grading system was structured was not covered by the interview. The energy KPIs are not integrated yet as it is still part of a pilot study. The raw material handling KPIs are also not integrated into the Code of Conduct system.

Company B has integrated all of its environmental KPIs into its supplier scorecard, where a supplier is ranked based on its performance in five categories: cost, quality, delivery rate, technology, and social and environmental performance. The social and environmental category is divided into five equivalent factors, see table 4.9.

Factors	Score
Code of Conduct compliance	
ISO 14001 certification	
Corporate Responsibility reporting	
Environmental Key Metrics	80 % if environmental KPIs are reported and reduction targets are in place, 100% if all reduction targets also are reached
Social Key Metrics	

Table 4.9: The category of company B's scorecard that concerns social and environmental performance. Environmental Key Metrics is what is called environmental KPIs in this thesis. The scoring is only shown for Environmental Key Metrics as this is what is important within the scope of this thesis.

The overall performance of energy, waste, and water, as well as in social aspects, is therefore just as important as for example compliance with the Code of Conduct. How the score is calculated is transparent to the suppliers, making it instructive since they thereby know what they should focus on. The score for the environmental KPIs (Environmental Key Metrics) is based on how many targets a supplier reaches during one year. Since targets often span over several years the score is based on set sub-targets. A supplier receives 80 % of the available points if it meets two requirements. The first is that it should report the environmental KPIs to company B. The second is that the supplier has reduction targets in place for each of the four environmental categories (energy use, GHG emission, waste handling, and water use). For each reduction target it is able to meet it gets an additional 5 %. This is due to the fact that company B's primary aim is still to encourage all suppliers to set reduction targets. In the future when this is has become part of normal practices focus will shift towards meeting the targets.

4.5.3 Supportive Actions

Apart from targets and scorecard integration the companies also take actions to support the suppliers in improving their environmental performance. The main strategy found is to provide them with additional resources. These are in many cases similar to the support given in the pilots of companies B, C, and D. For example, company B will provide a workshop for all of its suppliers that have had difficulties with the water use KPIs. An external water specialist will be invited in order to further train the suppliers and provide help with their problems. Another example is company A which this year will offer energy assessments to three of its suppliers that have struggled with their energy performance. These assessments will be carried out by the company's internal team of energy specialists and will be paid by the company. The suppliers are then provided with a list of improvements to improve their energy savings. If a supplier chooses to implement them, company A will offer to go in and do them at a cost.

Company C takes actions to improve their suppliers' water management, but these actions are coordinated from another office so the interviewee could not specify what type of actions it is. However, they did know that the company had a cleaner production program for water where in-house experts provide suppliers with solutions for more efficient and cleaner production processes. This approach is in a way an analogue to the energy audits and trainings by an environmental expert. One supportive action described by company E was that if a supplier is unable to treat its waste by any other means than landfill, the company provides countermeasures (as far as it is possible) at the factory to make sure that landfills are avoided. An example of such countermeasures could be to install a furnace for incineration or energy recovery. Since the interviewees only had access to European suppliers they could not say how difficult it was in other parts of the world. Although company D is still in its pilot project, it will keep some form of supportive actions after the pilot is over. The form these will take is discussed right now. However, the company feels that practical support, like energy audits, is more fruitful for experienced suppliers since it can challenge them by saying "you can do it like this".

The suppliers can also receive additional resources in a more indirect manner. If a major strategic supplier of company A has a problem with quality or cost then the company sends in its Six Sigma[1] people to try and help the supplier with the problem. Since company A and its suppliers are parts of an energy intensive industry, the cost problem can partly be associated with the high energy consumption. Solving the supplier's problem can therefore lead to a decreased energy consumption and greenhouse gas emissions as a consequence, although the supportive action is not directly triggered by the company's energy or greenhouse gas emission requirements.

Another important aspect of improving the performance of the suppliers, and maintaining a high reporting quality, was pointed out by companies C and D. They identified giving feedback to the suppliers on their progress and how they can improve as extremely important. The suppliers' motivation will drop if they do not receive it. As company D

[1]Six Sigma is a business management strategy to increase a product's quality by improving the overall production process. The objective of doing this is to either reduce costs and/or increase the profit of the company. (Pyzdek and Keller, 2010)

described it: “Feedback is an important ingredient in order to motivate the suppliers. If the data is sent into a black hole and nothing is heard from the company, the supplier will lose interest”. Feedback also allows the companies to actually “be managing the issues, not just looking back and seeing how a supplier had performed. It makes it possible to take actions more easily“ (company C). This was something company C currently could not easily offer its suppliers due to its manual reporting system and the amount of data that is reported through it, which limits the reporting frequency. The importance of feedback was further emphasised by company D. The company would rather keep the feedback it gives the suppliers, than to send out more sheets that need to be filled in.

Recognising and motivating the suppliers could however be done in other ways. Since last year (2010) companies A and B award a supplier with a special sustainability award. Apart from recognising the individual supplier’s efforts, it also sends a signal to the other suppliers that the company takes sustainability seriously. This will hopefully make them more committed to work with sustainability since it will improve their business relationship with the company. The criteria were not discussed in detail, but company B pressed that every supplier should be able to win the award since it is their efforts that are being awarded. The company also has plans to make the criteria open for all suppliers to further emphasize what the company think is important. Both the companies experienced the award to be well-received amongst the suppliers. Another way to motivate the suppliers is of course through a scorecard, since the better the suppliers perform, the more business-related benefits do they receive. According to company C, this extra motivation is less important for some environmental aspects. The reason is that some are win-win situations for the suppliers. For example, the more a supplier reduces its energy use, the more it reduces its costs. For other KPIs, such as water quality, this situation does not exist. It is therefore more important that such types of KPIs are integrated into the supplier scorecard.

5 Discussion

Since many of the interviewed companies were still in a pilot-phase it can be questioned if they are "front-runners" or not. However, since almost half of the companies that replied did not use environmental KPIs upstream in the supply-chain it can be argued that all five companies featured in this thesis are in fact front-runners since they have actually taken actions to implement such KPIs.

The first section of this chapter will compare the findings in the previous chapter to what can be found in the literature. The second section features a reflection on what can be learnt from these findings.

5.1 Comparison to Previous Research

From the findings it seems that most of the theory for environmental KPIs for in-house production is valid for 1st tier suppliers as well. Much like Bennett and James (1999) and the GHG Protocol (2004), the companies argue that both absolute and normalised indicators should be used, while the absolute is the most important since that is the actual environmental impact. The advantages and disadvantages experienced by company A for different types of targets are also confirmed by the GHG Protocol (2004). The benefits of using an environmental KPI for cost is discussed in the ISO 14031 guidelines (Kuhre, 1998), but not as detailed as the discussion provided by company D. The importance of reporting standards for in-house production (Ditz and Ranganathan, 1997) is confirmed and extended to the supply-chain by the companies, where it might be even more important in order to avoid supplier fatigue. Furthermore, the lack of used reporting standards that was identified by Brewer and Speh (2001) still seems to be present, although it has been greatly improved within the area of energy use and GHG emission with the addition of the GHG Protocol. There is also potential for further improvement with reporting standards such as the WFAM. The recommendation by the ISO 14031 guidelines (Kuhre, 1998) to design KPIs so that they promote benchmarking seems hard to reach due to the companies' difficulty to have one single type of allocation unit that is valid for all types of suppliers and production processes (incl. in-house production).

There is also a great deal of overlap between the findings and the theory of GSCM and performance measurements of the supply-chain. All companies had a cross-integrated approach to their GSCM and the companies acknowledged the importance of rewards and recognition of the suppliers, as proposed by Hervani *et al*. (2005). The importance to integrate the environmental KPIs into a scorecard stated by Bennett and James (1999), Hervani *et al*. (2005), and Kaplan and Norton (1992) was confirmed by the companies, although only two had in practice done it. That so few companies have integrated environmental KPIs into their supplier scorecard indicates that the area of environmental KPIs is still to some degree in its cradle and is not yet a fully integrated area in company business. Still many have plans to integrate them into a scorecard in the future, meaning that they recognise Green Purchasing as an important step in greening the supply chain. The importance of the companies' knowledge exchange between suppliers in the workshops and the actions to address the suppliers' knowledge gap for environmental

issues are confirmed by Cheng *et al*. (2008) plus Handfield and Nichols (1999) and Hu and Hsu (2010), respectively.

There are also some findings that are not well-described in the literature. One of the most important "gaps", especially considering how to accomplish a high reporting compliance, is strategies for implementing the KPIs at the suppliers. Another important "gap" is the limitations of the data collection method for the supply-chain – a method that is currently completely manual judging from the five interviewed companies. As it is now, the companies are not able to properly manage the environmental KPIs. The reporting frequency is low and efforts to verify the data quality are limited to avoid a too high workload for the company and the suppliers. The current format also adds extra workload to the suppliers, which have to fill in one spreadsheet for each focal company that demands environmental performance measurements. In order to avoid a too high workload it is therefore important for companies to know what are reasonable data verification methods and reporting frequencies, to mention a few examples. Such recommendations are not well-discussed in the literature.

5.2 Reflections and Recommendations

In this section the results from chapter 5 "Analysis and findings" will be reflected upon. The focus will be on the challenges the companies have experienced, as well as discussing recommendations for how to avoid these challenges in the future.

5.2.1 Used KPIs

Judging from both the literature and the companies' experiences it seems like the best approach is to use both absolute and normalised indicators for the amount used/generated for each reported environmental category (i.e. energy use, GHG emission, raw material handling, waste handling, and water use). Since a supplier should have information about its production volumes and turnover, it will have all the necessary information to do the transformation from absolute to normalised amount. Using two indicators should therefore not cause any significant increase in workload. In order to include all major relevant environmental aspects, these KPIs could be complemented with category-specific KPIs, e.g. water quality or waste treatment method. Since one of the reasons that preventive environmental work has become so popular within industry is the ability to cut costs, it only makes sense to include cost KPIs. However, it is important that the environmental aspect can be translated into a cost and that the additional KPIs do not increase the workload too much. This will enable companies and suppliers to track their cost reductions and further communicate the benefits of managing the different environmental impacts.

A solution to company B's problem of using normalised indicators to provide more measured data for LCA's could be to normalise using standard units. Since each product would correspond to a certain number of standard units it would be possible to calculate backwards and get a better approximate value of how much resources are required to manufacture one specific product. The issue of different production processes still

remains however. The idea was therefore bounced with company D after the interviews. The company saw standard units as a possible application for LCAs, although it did not do so itself. The issue of different production processes could be solved as long as the right approximations were used for each production process when determining how many standard units a product corresponds to. How difficult this is remains unclear and requires further studies. The standard units can therefore also be used to solve the companies' problem of normalising the indicators so that it would be possible to compare the suppliers. However, this would make it completely impossible to compare and benchmark different focal companies against each other since the companies would most probably come up with their own set of guidelines on how to convert into standard units. It would even further increase the suppliers' workload since it would get one set of definitions from each focal company. The solution would then have to be a global standard used by all companies. How large the motivation is among the companies to develop such a standard is unclear. To fully compare suppliers, the focal companies would also have to take into account if and how much of a supplier's production is outsourced to a sub-contractor. How to do this practically remains a challenge.

The companies also had difficulties determining how a supplier should allocate for each focal company's share. A further problem was how the companies could verify this share without examining sensitive information. No definitive way to do either of this could be reached through the interviews or the literature. Of the suggested methods it seems like the best way to do it is to let the supplier itself do the estimation and not provide a percentage of either the total turnover or the production volume. The reason is that it is possible for a focal company to calculate backwards and get the total production volume and turnover if it is provided with a percentage, since the focal company knows how many products it has ordered, or their value. To maintain the integrity of the supplier and avoid any leak of information regarding competitors, this approach should therefore be avoided. As the production processes of the suppliers differ it cannot be said if allocating per production volume or turnover should be preferred, and it seems difficult to only use one approach for all suppliers.

The importance of reporting standards to gain uniformity in the environmental reporting is visualised by how homogeneous the energy use and GHG emission reporting is. In contrast the reporting for waste handling and water use is heterogeneous, since the companies do not use any reporting standard. The waste handling reporting of companies B and E are fundamentally different and complement each other, and should not cause any difficulties for a supplier should it have both as focal companies. However, there are some concerns about how the suppliers of companies B, C, and E report on their water use. The lack of consensus of how to measure "used water" can make a supplier confused if its focal companies use different definitions. This can in turn cause supplier fatigue. In addition, by measuring the water use as the amount of water that is discharged (meter in the suppliers' effluent water treatment plants) means that no account for vaporised water is taken. More water can therefore be used in the production processes than what is measured, meaning that the actual environmental impact is larger than what is reported. To solve the problems caused by the different definitions in use, it is a good idea to adapt a reporting standard for water reporting, such as WFAM.

A highly relevant topic, but one that was not covered in most interviews, is the challenge experienced by company B on how to design and select the KPIs so that they provide guidance for each tier in the supply-chain as well as for the diversity of suppliers within each tier. Since this thesis did not properly cover this area it is hard to draw any conclusions on how to do this selection. It therefore requires an additional research to explore it.

5.2.2 Implementing the KPIs

By comparing the companies' different implementation strategies it seems that it is less successful to gain a high compliance rate by requiring that the suppliers should report on their environmental performance without giving them any additional support. This additional support is important. The reason is that the suppliers often seem to have little understanding of why it is important to manage their environmental impacts and/or how it can benefit them. The lack of knowledge was also seen as one of the main causes behind a low quality of reported data. The approach of companies B, C, and D to use extensive pilots to implement the KPIs therefore seems to be preferred over company A's approach. A general trend for these extensive pilots is to provide the suppliers with theoretical support by organising a workshop. In these workshops the suppliers meet in person and receive training on the environmental issues by an (external) expert. Since the suppliers meet they are also able to exchange ideas and experiences, further improving their performance. It also improves the performance of the supply-chain as a whole. The suppliers also receive practical support in terms of free environmental audits. In the interviews only energy audits were mentioned, but there are no reasons to why environmental audits should only be limited to energy issues.

A difference between the pilots is that companies B and D started with a small group of suppliers and step-by-step increased the amount of suppliers which reported. Company C on the other hand started directly with approximately 100-120 of its suppliers. However, these suppliers are divided into several smaller projects, making it easier to handle. A possible drawback with the approach of company C is that it starts directly with a large amount of data that needs to be managed. In the approach of companies B and C, the amount of data that is reported is instead gradually increased. The pilot of company C is not yet finished so it is not possible to say how successful it is. A point of concern is however that company C might get swamped with an amount of data which it cannot handle. Especially when comparing the approach to the one by company A, where one of the reasons to lower the amount of suppliers was to be able to handle the incoming data. Company D has also not yet finished its pilot project, while the KPIs of company B are fully integrated into business. Since the data provided in this thesis is limited, it is impossible to say if the step-by-step approach or the approach to include all suppliers at once should be preferred. All that can be said is that the step-by-step approach has proved to be successful, while the outcome of including all suppliers at once remains unclear. The issue of financing such an extensive pilot project seems to be less of a concern as it seems that they partly or fully can be sponsored by local authorities, at least in some Chinese provinces (where many companies have suppliers).

5.2.3 Collecting Data for the KPIs

Almost all problems associated with collecting, verifying, and managing the KPI data are caused by one thing: the manual data collection method currently in use and its heavy workload. It therefore seems very important that companies adopt a software-based reporting platform if they decide to manage the environmental impact from their supply-chain. This will minimise the workload and thereby also minimise the risk of supplier fatigue. It also makes more resources available in the company to actually be able to manage the incoming data.

Three approaches to acquire such a reporting platform were used by the companies. One was to buy an existing reporting tool on the marked. The second approach was that the company, with external help, developed its own company-specific reporting tool. The third was to expand a pre-existing internal system for in-house production to also cover suppliers. Since there currently are no global standardised reporting platforms available, the suppliers would still have to report using different reporting tools for each of their focal companies. This will not lower the suppliers' workload by much. Steps towards such a standardised reporting platform should therefore be taken. A company could be hindered to implement a software-based reporting platform for its suppliers due to various reasons, e.g. instable reporting process. In that case, it could be a good idea for the company to at least have an internal data management system. This will make the internal KPI data management processes more automatic, decreasing the company's workload.

The reporting platform would enable better verification of the incoming data. However, the actual measurements still have to be controlled, and this can only be done by visiting the supplier. Although the companies trusted their suppliers to measure and report the data correctly, it does not say that no misunderstandings about how to measure can occur. These misunderstandings can only be revealed by checking how a supplier does the measurements in practice. However, there are many things which should be covered during an audit. Depending on how large the problem is with suppliers measuring data incorrectly, it might be more efficient to put more effort into preventive actions instead. Such preventive actions could be to provide more guidance, training, and feedback. The latter will also motivate the suppliers; a key factor to guarantee a high reporting quality according to companies C and D.

All companies wanted to increase the reporting frequency to better manage the KPIs. Until a company implements an adequate reporting platform it is important that the reporting frequency still is high, but not so high that it causes a too heavy workload for the company and its suppliers. From the interviews it seems like the reporting frequency limit is about twice per year, even though a lot of KPIs are in place and a majority of suppliers report (company B). A reporting frequency that is higher than this seems to cause a too heavy workload. However, it should be mentioned that it also depends on the available workforce to report and manage the KPI data which can vary between suppliers and focal companies. If a supplier for example is well-developed at measuring its environmental impact, the reporting frequency could be increased.

5.2.4 Improving the Supplier Performance

Overall, the companies acknowledge the two main strategies (targets and scorecard integration) to improve the environmental performance of the suppliers. The main limitation to why all companies have not set targets or integrated the KPIs into a scorecard is because they are still in the pilot phase of their environmental KPIs. Apart from these strategies there also seems to be a need to provide theoretical and practical support to help suppliers with a low performance. The companies also provide some practical actions to motivate the suppliers to manage their environmental impact and improve their performance. The three major actions are: direct feedback on their reported data, awarding a high performing supplier, and the incentives from the supplier scorecard. The latter is covered by the theory of balanced scorecards, while the first one currently is hard to achieve due to the manual reporting method. An award should be a relatively easy measure for a company to take, minding that it should be possible for every supplier to win.

The companies stressed the importance to lower the absolute amounts of their suppliers, e.g. GHG emissions, waste generated, or water use. However, absolute targets are sensitive to variations in production volume. It therefore seems that normalised targets should be preferred, since they are independent of such variations. Thus, they are more true to how well a supplier manages its environmental impact. The absolute amounts might still not be lowered if the production volume increases. The environmental impact would then either be unchanged or increased. However, it would still be lower than what would have been the case had not the efficiency been improved. Since it is hard to set absolute targets, the actual environmental impact could instead be lowered using supplementary targets to the normalised ones. Such supplementary targets could be set to increase the percentage of used sustainable sources (e.g. renewable energy) or sustainable handling of waste (e.g. more recycled) (where possible). That way, the efficiency of the production processes would improve and the environmental impact of the resources still needed would be smaller. An analogue argument can be made for the generated waste. However, the complexity of setting targets is greater than that. In order to give it justice, it would require a separate study in itself.

There is also the problem of background energy. As important it is to set targets to improve the energy use per production volume, it is also important to set targets to improve the efficiency of supportive systems. It is possible that other environmental aspects than energy use are affected by a similar phenomenon. Although some water is incorporated into products, it is to a large degree also used for cooling, heating, and washing. These aspects are more likely to be independent of the production volume, at least to some degree. Water use KPIs might therefore be prone to a phenomenon similar to background energy. Waste and amount of purchased raw material should not be affected, since they should only depend on how much is produced, i.e. the production volume.

6 Conclusion

Returning to the initial research question: "To what extent do front-runner companies use environmental KPIs to manage the environmental performance upstream in their supply-chain?" Front-runner companies primarily manage environmental issues concerning energy use and GHG emission and secondly on water issues for 1st tier suppliers. Some companies also manage raw material and waste handling, although no company manages all four using KPIs. Which environmental aspects their suppliers report on within these areas differs. There is however a great homogeneity within energy use and GHG emission – largely because of the high use of the GHG Protocol guidelines. The most widespread KPI types are absolute and normalised indicators for resource use and generation of waste and emissions. The two indicator types are often used in combination to give a true picture of a supplier's environmental performance. These KPIs are if needed complemented with KPIs specific for a certain environmental category, e.g. water quality. The companies often also require the suppliers to report on the company's share of their production.

The majority of the companies implement the KPIs using pilot projects. In these pilot projects the suppliers are provided with theoretical as well as practical support to guarantee a high compliance rate. The data collection of the KPIs is currently completely manual using spreadsheets. Rather few actions are taken at the companies to verify the quality of the reported data and how it is measured. Instead, the suppliers are trusted to provide correct data. The interviewed companies that were still in the pilot phase of their environmental KPIs did not take any actions to improve the environmental performance of the suppliers. The more experienced companies often had targets in place and integrated the KPIs into their supplier scorecard. The companies also took actions to recognise suppliers' work to improve their performance as well as motivating them to work harder, for example through awards. Suppliers which experience difficulties with their performance are provided with appropriate support, often similar to the kind of support provided in the extensive pilot projects.

The second question asked: "What challenges have the companies experienced concerning the selection, implementation, data collection, and performance improvement of the environmental KPIs?" The companies had experienced numerous challenges. The largest of them was the manual reporting system which was associated with a heavy workload, both for the companies and their suppliers. The heavy workload restricted the companies' ability to properly manage the incoming data. It also limited the reporting frequency to a maximum of twice per year, and often just annually. To solve these problems the companies would like to move, or are already moving, to a software reporting tool where a lot of data management processes are automated and all sustainability KPIs are included. Suppliers often had several focal companies demanding environmental KPI reporting, where each focal company had their own KPIs and standards. This further increased the workload of the suppliers. A secondary requirement of the reporting tool was therefore that it should be possible to be used by all focal companies. This requirement is however not met by any of the reporting tools the companies are on the way to implement. A second big challenge was how to set targets to

reduce the total environmental impact of a supplier. To do that, the companies need to set absolute targets, but these vary with fluctuations in production volume. The companies therefore preferred to set normalised targets, since these are independent of production volume. A drawback is that it is not then guaranteed that the actual environmental impact will decrease, since it can still increase if the production volume increases. A third big challenge was that there are in principle not any globally accepted reporting standards apart from the GHG Protocol. This causes each company to have their own reporting standards. It is therefore almost impossible to benchmark the environmental performance of the companies' supply-chains. The workload of the suppliers is also increased, as they have to use every individual reporting standard of their focal companies. A fourth challenge was the allocation used for the different indicators. Currently it is impossible to compare the normalised indicators of the suppliers since the production processes vary too much. The suppliers often also select the allocation unit themselves, so that it best suits their operations. A fifth challenge is that none of the companies included sub-contractors to the 1st tier suppliers in their reporting. Since some suppliers have outsourced production to sub-contractors, it makes it even harder to compare suppliers. It was also hard to verify that the company's share was correct. The reason for this was that the companies could not access the suppliers' figures for their total turnover or production volume, as this was sensitive information. Unfortunately, there were no solutions to the last three challenges. In order to make KPIs truly efficient for managing the environmental impact of the supply-chain, these issues have to be solved.

Most of the findings could be confirmed by previous research, either on environmental KPIs for in-house production or on GSCM. It also emphasises the importance of developing KPIs to manage the environmental impact from the supply-chain. However, it is not as detailed or practically orientated as the descriptions provided by the interviewed companies. The companies also agree that KPIs is the right approach to manage the environmental impact of the supply-chain, since you cannot manage what you do not measure. Two main findings were not well-described in the literature. One was how to implement the KPIs at a supplier. The other was the limitations of the widespread manual data reporting system used by the companies.

To further expand and improve the area of environmental KPIs for suppliers upstream in the supply-chain, there are some aspects which should be investigated further:

- How should targets be set to actually decrease the environmental impact of a supplier, as well as be insensitive to fluctuations in production volume so that a supplier's true performance can be evaluated?
- How could sub-contractors practically be included in the environmental KPI reporting of 1st tier suppliers?
- How should KPIs be designed so that they are relevant and provide guidance for the variety of suppliers in a tier as well for different tiers?
- How should normalised indicators be designed to allow suppliers to be compared against each other, as well as enabling benchmarking of different focal companies' supply-chains?
- What is the best balance between the amount of used KPIs and the ability to manage them, compared to the respective running costs, e.g. manpower?

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Appendix A: Analysing Matrix for Screening Companies

If a cell is left blank for a company it means that no information could be retrieved for that certain category.

Company name	**Example 1 Inc.**	**Example 2 AB**
Extent of supply-chain covered by KPIs		1st tier
KPIs - Energy use	Yes, no details	Energy consumption (GJ)
KPIs - Raw material handling		
KPIs - Waste handling		Yes, no details
KPIs - Water use	Yes, no details	
Targets		Reduce cradle-to-gate carbon footprint with 20-25 % by 2020
Conducted LCAs		Energy
Reports on Scope 3 of GHG Protocol		Yes
Member of Carbon Disclosure Project's Supply Chain Programme	No	Yes
Endorsement of UN CEO Water Mandate	Yes	No
Partner of Water Footprint Network	Yes	No
Other green supply-chain initiatives	Better Cotton Initiative	
Environmental aspect in Code of Conduct	Yes	Yes
Sub-requirements for suppliers	No	ISO 14001
Green claims		
Green labels		
Awards	Dow Jones Sustainability Index Supersector Leader	

Appendix B: Questionnaire for Gathering Environmental KPIs

B.1 The questionnaire

KPIs for energy use			
KPIs for energy use concerns KPIs related to energy aspects **EXAMPLES OF ASPECTS (not KPIs): .** **energy consumption (kWh), greenhouse gas emission (e.g. CO2), and energy source**		**KPI 1**	**Etc.**
Title of KPI	***EXAMPLE: Energy consumption***		
Purpose	*Monitor the rate of improvement of our suppliers, driving down the total energy consumption*		
Unit	*total amount of kWh*		
Calculation of KPI (incl. parameters)	(Please see document "Guidelines for questionnaire")		
Target/goal	*30% reduction by 2015 (2004 baseline)*		
Frequency	*Every month*		
Source of used data	*Supplier-specific data and database*		
Extent of supply-chain	*1st tiers and their subcontractors*		
Notes and comments			

KPIs for raw material handling			
KPIs for raw material handling concerns KPIs related to raw material aspects **EXAMPLES OF ASPECTS (<u>not</u> KPIs):** **recycled, reused, and renewable material and material efficiency**		**KPI 1**	**Etc.**
Title of KPI	***EXAMPLE: Amount of recycled material***		
Purpose	*Stimulate use of recycled materials for suppliers*		
Unit	*% of total raw material use that is recycled material*		
Calculation of KPI (incl. parameters)	(Please see document "Guidelines for questionnaire")		
Target/goal	*10% improvement by 2020 (2008 baseline)*		
Frequency	*Every quarter*		
Source of used data	*Supplier-specific*		
Extent of supply-chain	*Cradle-to-gate*		
Notes and comments			

KPIs for waste handling

KPIs for waste handling concerns KPIs related to waste aspects EXAMPLES OF ASPECTS (not KPIs): waste issues such as destination (e.g. landfill) and type of waste Material efficiency can as well be seen as waste handling, however clarify if seen as raw material handling or waste handling at your company			
		KPI 1	Etc.
Title of KPI	***EXAMPLE: Amount of waste to landfill***		
Purpose	*Minimize waste going to landfill*		
Unit	*Tonnes of waste to landfill per tonnes generated waste*		
Calculation of KPI (incl. parameters)	(Please see document "Guidelines for questionnaire")		
Target/goal	*0% by 2030 (2005 baseline)*		
Frequency	*Every second month*		
Source of used data	*Supplier-specific*		
Extent of supply-chain	*All 1st tier suppliers*		
Notes and comments			

KPIs for water use

KPIs for waster use concerns KPIs related to water aspects EXAMPLES OF ASPECTS (not KPIs): water quality, water consumption, and type of water that is used			
		KPI 1	Etc.
Title of KPI	***EXAMPLE: Water efficiency***		
Purpose	*Increase water efficiency of suppliers*		
Unit	*Litres of water per kg of product*		
Calculation of KPI (incl. parameters)	(Please see document "Guidelines for questionnaire")		
Target/goal	*20% reduction by 2013 (2008 baseline)*		
Frequency	*Every month*		
Source of used data	*Supplier-specific*		
Extent of supply-chain	*1st and 2nd tier suppliers*		
Notes and comments			

Comments
[1] If a box cannot be answered, please answer "N/A"
[2] Please see the guidelines document for how to fill in the questionnaire

B.2 Guidelines for filling in the questionnaire

General

The objective of the questionnaire is to gain basic knowledge about your company's KPIs for the *supply-chain* and enable a more in-depth focus for the interview. It also serves as a guarantee that all of your KPIs will be analyzed in the benchmark, as it is not certain that all of them are featured in the sustainability reports and/or website.

The questionnaire itself is divided into:

- 4 sheets, one for each environmental aspect
- 9 elements detailing information regarding each specific KPI

Each sheet has an example to give some guidance on how to fill in the questionnaire. No example exists for calculation of KPI as this can vary a lot between companies.

Time requirement

It is estimated to take 15-30 min to fill in. If more time is required and you cannot spare any, please focus on the environmental aspect where you feel your company is the most developed in.

Environmental aspects

- **Energy use:**
  Concerns energy issues such as energy consumption (kWh), greenhouse gas emission (e.g. CO_2), and energy source.
- **Raw material handling:**
  Deals with used (raw) material issues such as recycled, reused, and renewable material and material efficiency.
- **Waste handling:**
  Regards how waste issues such as destination (e.g. landfill) and type of waste. Material efficiency can as well be seen as waste handling, however clarify if seen as raw material handling or waste handling at your company.
- **Water use:**
  Concerns water issues such as water quality indicators, water consumption, and type of water that is used.

Please note that the mentioned examples under each aspect are only examples. They are not in any way fully-covering so do not let them limit you while filling in the questionnaire.

Elements in questionnaire

- **Title of KPI:**
  The name of the KPI
- **Purpose:**
  The purpose of the KPI. Why is it used and for what?
- **Unit:**
  What is the functional unit of the KPI. Is it total amount, a certain ratio per product or sales, etc.
- **Calculation of KPI (incl. parameters):**
  The used formula for calculating the KPI, i.e. the used parameters and how they are calculated.

- **Target/goal:**
  Are there any targets/goals set regarding the KPI? If so, how large improvement, by when, and what baseline is used?
- **Frequency:**
  How often is the data reported by the supplier?
- **Source of used data:**
  What type of data is used for the indicator. E.g. is a generic database used or is it supplier-specific?
- **Extent of supply-chain:**
  How much of the supply-chain is incorporated in the KPI? E.g. 1st tier suppliers, 2nd tiers, or cradle-to-gate? See figure B.1.
- **Notes and comments:**
  If you have any comments or notes, feel free to fill it in here.

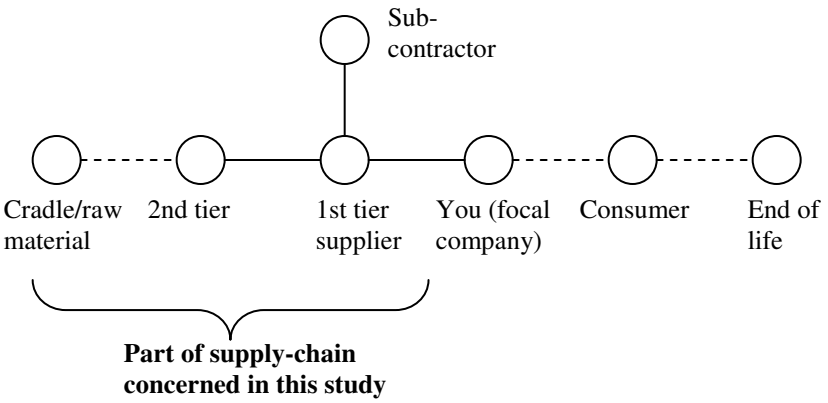

Figure B.1: Terminology and scope of supply-chain.

Appendix C: Interview Questions

The following section details which questions were asked during the interviews. However, these are general for all companies. For each specific interview the questions were adapted after how much and what type of information could be obtained from the questionnaire as well as from the corporate website and annual/sustainability/ environmental/CSR reports. Follow-up questions were also asked where suitable.

General

- What is/are your role(s) at your company?
    - What tasks are included in this role?

- How is the sustainability team that works towards the supply-chain structured at your company?

- How long has your company been using sustainability KPIs for your suppliers?

- Complementary questions about information on the company's website and questionnaire (if needed)

Collection of data

- What type of reporting tool or method do you use to collect data for the KPIs from the suppliers?

- Do you review if a supplier measures and reports data for the KPIs in a correct way? If so, how do you do it?

Measures for improving KPI performance

Do you take actions towards the suppliers based on their KPI performance?

- If no, what plans do you have for the future to take action based on their performance?

- If yes, what actions do you take?

- Does the performance of the KPIs influence sourcing decisions? If so, how does it influence? I.e. change supplier, larger and longer order contracts, etc.
    - Are the sustainability KPIs integrated with business KPIs, e.g. in a scorecard?

- Do you take actions to improve the environmental performance of the suppliers? If so, what actions?

- What actions do you take if the reported KPI performance from a supplier fails to meet your demands?

Selection of KPIs

How did you select the KPIs which you are using or are on your way to implement?

- What processes did you go through to select your KPIs?
    - Who took part in this process to select the KPIs?

- Do the KPIs relate to any of your company's business strategy/objective/goal? If so, which?
    - Do the KPIs relate to any company strategy/objective/goal to improve your company's environmental performance? If so, which?

- How often are the KPIs and business objectives up for discussion/revision within your company?

- From what corporate level are sustainability targets for the supply-chain communicated both within your company and to the suppliers? **(5)**

Efficiency

How effective would you say that the KPIs have been in increasing the environmental performance of your suppliers?

- If yes, in what way have they been effective?

- If no, in what way have they not been effective?

- How much has your company been able to increase the environmental performance of your supply-chain using the KPIs? What time-frame?
    - What part have the KPIs by themselves played in this increase?

Reactions and traps

What unexpected results and events caused by factors in KPI-design and implementation have you experienced while using the KPIs?

- E.g:
    - Inability to obtain relevant data from supplier(s)
    - Supplier does not measure data for KPI correctly
    - Failure to reach a goal due to wrong units for the KPI(s)
    - Lack of sufficient KPIs

- Which elements concerning the design and use of the KPIs have you already improved or would you like to improve?

- What have the reaction been from the suppliers to use the KPIs?

Other comments

Do you have any further points you would like to raise concerning the 5 covered themes; collection of data, follow-up of data, relation to objectives, efficiency, and traps?