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Supply Chain Emissions
Case study: Scope 3 emissions at KPN

by

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Supply chain emissions (Scope 3 emissions)

A case study on scope 3 emissions and optimization of insights available from suppliers for KPN at TO Energy and Environment

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by

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Acknowledgement

This thesis represents the result of my graduation thesis, needed for a master's in Maritime Economics and Logistics at MEL Erasmus University Rotterdam. This was my first full-time internship in a business setting, and it was full of obstacles. This research aimed to optimize the insights available from vendors related to scope 3 emissions and particularly for category 01 purchased and goods.

Firstly, I would like to thank KPN (The network of Netherlands) for giving me an opportunity to conduct my research thesis. Thank you Jeroen cox and Edwin Rutten for the supervision and enthusiasm from the KPN Energy and Environment office. I would also like to thank my thesis supervisor, Prof. Ted Welten, for his valuable feedback, which helped me to structure my thesis. I would also like to thank the people from MEL office: Renee, Mariem, Felicia and Martha for answering all my queries at the earliest and for guiding me throughout my course.

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I'd also want to thank everyone who assisted me over the past few months. I'd like to thank you for your patience during my thesis period; now it's time to keep up the excellent job and use what I've learned in my thesis to my new projects.

Best of luck to everyone!

Enjoy reading my thesis!

Nikhil Mishra

Capella Aan Den Ijssel, Rotterdam

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Abstract

This research represents a product-based approach for scope 3 emissions category 01 purchased goods and services, category 04 upstream transportation, category 09 downstream transportation, emissions during category 11 use phase, and category 12 end-of-life phase. This research is done at KPN to formulate and optimize a product-based approach for the calculation of the above-mentioned categories. The main research topic this thesis is attempting to explain is: *How can we optimize the insights received from the suppliers/vendors to lower supply chain emissions towards net zero carbon foot print in the supply chain?*

This research begins with determining the scope 3 emissions calculation methods used by most telecom organizations. The research is focused on the product-based approach with the organization. The factors which play a major role in optimizing the information available from top key vendors as scope 3 emissions deals with indirect emissions from the suppliers within the organization. The research is supported by the case study at KPN Energy & Environment (KPN E&E) and is scoped to investigate and optimize the product-based approach.

Most telecom organizations are using either spend based method or average based method. They are reluctant to use either of the methods depending on the availability of data. To ask for data from the suppliers related to products, transportation, and other services is a heavy job because in most cases they are not ready to share and in other cases, they don't have it. However, the other way to get data with all the provided answers related to carbon footprint is LCA (Life Cycle Assessment) report. LCA is a process that tells us about the total carbon emission for a product during the entire life cycle process.

This research concluded that we need both an organizational approach and a product-based approach for the precise calculation of scope 3 emissions. We need to engage suppliers to optimize the product-based approach. We can do that either by organizing more webinars based on products and LCA's or by engaging them to provide data.

This research ends with recommendations for further research. A similar study is needed to be done to know more about product design and deep dive into LCA's report. We need to research Eco Invent database used by LCA's tool (SimaPro and GaBi).

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List of Abbreviations

LCA: Life cycle assessment

GHG: Greenhouse gas

GWP: Global warming potential

EEIO: Environmentally extended input output data

NE: Network equipment

MNM: Mobile network (Radio access network)

ETN-IP: Ethernet – IP network

OTN: Optical transport network (KPN wavelength division)

TQM: Total quality management

OEM: Original equipment manufacturer

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1

Introduction

This chapter provides an overview of the research undertaken in this thesis. It will set the scene and introduce the case study undertaken at KPN. The core objective and scope of the main research topic and the sub-research questions is introduced. Finally, the thesis methodology and structure is described.

1.1. Research context

Different organizations in Europe are working towards carbon neutrality (as per Paris agreement). The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 parties at COP 21 in Paris. "The goal is to limit global warming to below 2 degrees Celsius, preferably to 1.5 degree Celsius, as per pre-industrial levels" ***(United nation climate change: Paris agreement).***

Companies around the world and in all industries are working towards calculating their carbon emissions produced by different supply chain activities. "To succeed in that leading GHG Protocol corporate standard, a company's greenhouse gas emissions are classified into three scopes. Scope 1 and 2 are mandatory to report, whereas scope 3 is voluntary and the hardest to monitor. However, companies succeeding in reporting all three scopes will gain a sustainable competitive advantage" ***("Optel: Carbon Footprint").*** This research focuses on reporting scope 3 emission as it contributes around 75-80% of the total emission.

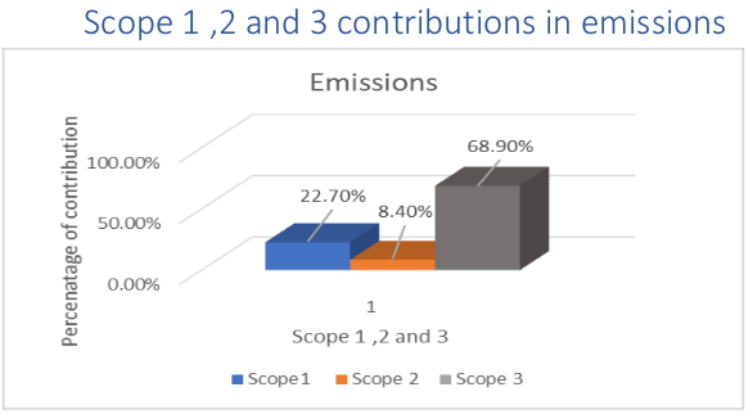


Figure 1.1: Contribution of Scope 1,2, and 3 in climate change (data taken from Rio Tinto)

As we can see scope 3 contributes the majority of emissions as compared to scopes 1 and 2. However, the organization doesn't need to report that. But if the organization wants to go carbon neutral, the companies need to lower all three emissions. For the industries to report scopes 1 and 2 is not challenging where as for the organization to report scope 3 is a bit of a hassle as scope 3 deals with indirect emissions from the suppliers.

1.2. Research field

This research is conducted for Erasmus University, supported by the case study within the office of KPN. KPN is the leading service provider company in the Netherlands for telecommunications and information technology (IT) services. The company offers a portfolio of services including fixed and mobile telephones, mobile data, and internet to small, medium, and large size business customers. For KPN they have set a target to achieve carbon neutrality i.e., carbon net zero by 2040 and 100% circularity by 2025 as KPN strives to connect everybody and everything in a sustainable way.

This research focuses on scope 3 emission in the supply chain, a very important key component in the strategy to achieve carbon neutrality for KPN as it contributes the maximum in the total contribution in emissions. Scope 1 and 2 have been reduced to 0 in comparison to the base year 2010 which was 119.7 (kilo ton). However, for scope 3 in 2021, it reduced by 22% as compared to the base year 2014 which was 196.2 to 169.2 (kilo ton) having a goal set to go net zero by 2040.

KPN has set a goal of going net-zero by 2040 that could only be achieved by reducing scope 3 emissions. Reduction in scope 3 has three main processes on a strategic level:

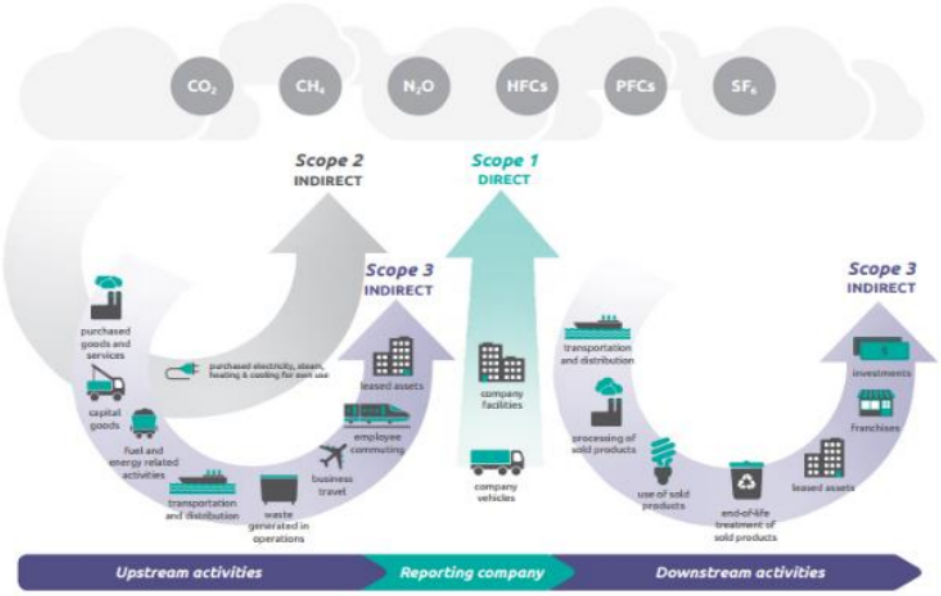
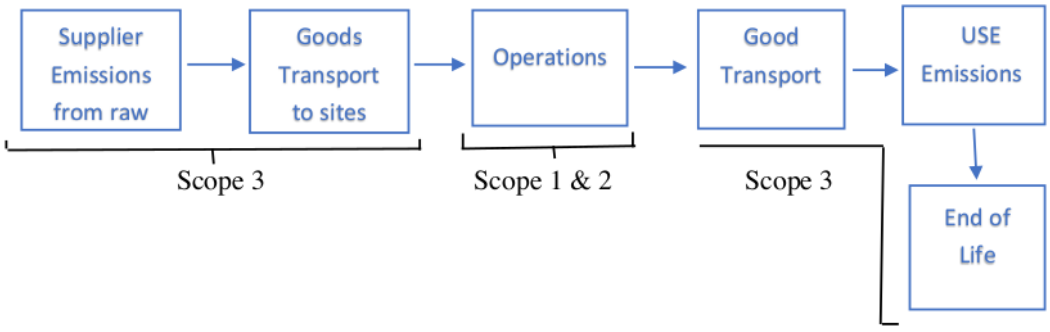


Figure 1.2 (Source: GHG Protocol world resource institute (Scope 1, 2, and 3))

1. Set clear expectations
2. Strategically engage with your key vendors
3. Cascade science-based targets through your supply chain

These three strategies can be subdivided into different steps to achieve the net zero goal.

Figure 1.3: Decarbonization across the value-chain

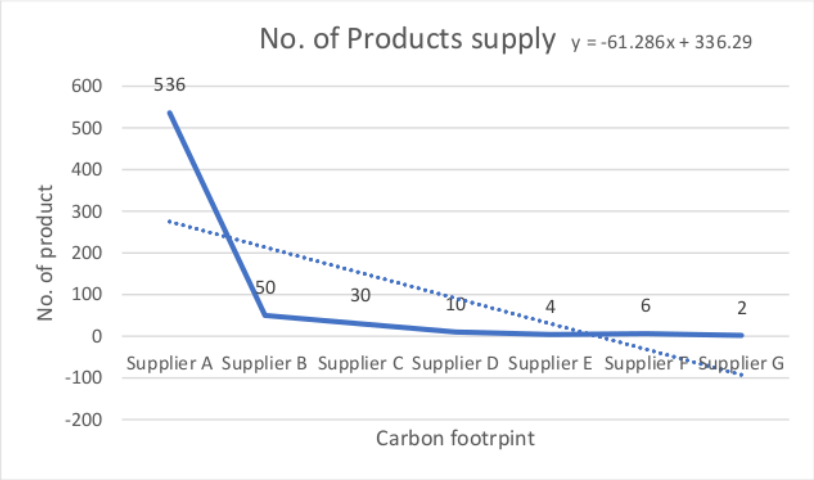


From this overall value chain, a dashboard is created with several result key- performance Indicators (KPIs) that are used to optimize the process. The suppliers need to provide the relevant data for the value chain process.

1.3. Research problem definition

This research focuses on standardization of the inputs received from the vendors/suppliers to lower scope 3 emissions in the value chain. To understand the value chain for scope 3 and to know the key aspects, an analysis must be performed to evaluate scope 3 emissions. Furthermore, research needs to be done on how value is added and measured within the boundaries of scope 3 emissions which are indirectly related to the organization. One of the objectives of this research is to understand how to standardize the inputs from vendors about scope 3 emissions. To do so, the key performance indicators (KPIs) need to be understood. For the best optimization of the inputs, we need to find the main KPI.

Figure: 1.4 (Trendline for suppliers contributing in No. of Products



As stated before, The KPI for the scope 3 emissions is shown with a help of the graph where the supplier contribution is on the higher side if the number of products is more as compared to supplier supplying lesser product. The trendline equation [y= -61.286x + 336.29] shows suppliers' contribution decreasing due to contributing lesser number of products. Equation of line: Y = mx+c [m = slope, x= x-intercept, c = y-intercept]

Note: For the supplier, supplying the majority of products in the same domain (for example: Electronics or similar products from different vendors) the carbon footprint will be on the higher side.

The research problem for this thesis is defined as follows:

The research problem of this thesis is to calculate scope 3 emissions, we have applied product-based approach, how can we get the most use of insights which we get from our top key suppliers based on the number of quantity they provide to an organization?

1.4. Research Scope

This research focuses on identifying the suppliers who are directly contributing to the Scope 3 emissions of the KPN. Scope 3 emissions are indirectly related to the organization's emissions which are equally important for the organization to reduce to get a net zero carbon footprint.

In reducing scope 3 emission, the organization has to deal with all the data provided by the suppliers for a product that they supply to the parent organization. To evaluate the scope 3 emission for a particular product is a cumbersome job and for calculation, we need to calculate the emissions from the extraction of raw material, manufacturing, transportation, use phase, and disposal phase.

Figure 1.5: Life cycle assessment Step-by Process

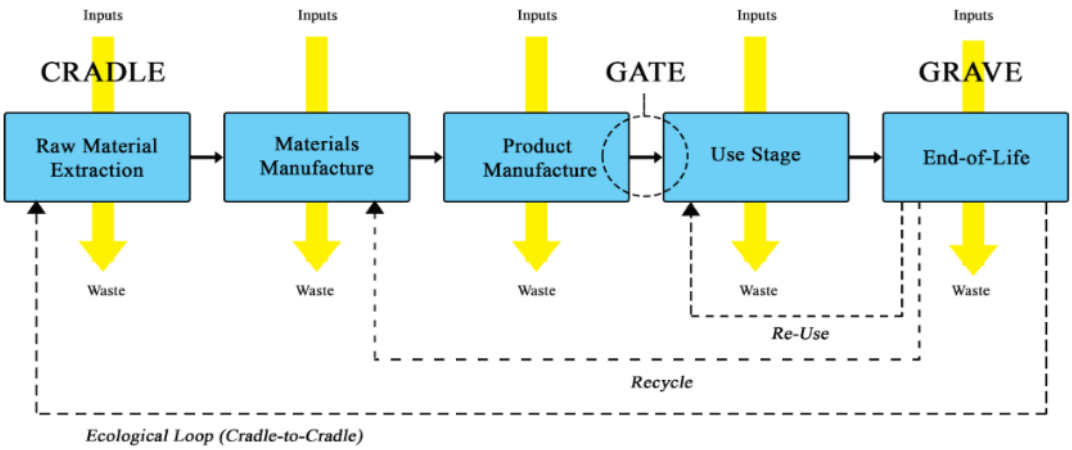


Figure 1.4 shows different stages of LCAs within the scope.

This research will focus only on suppliers' engagement in scope 3 emissions. To evaluate the carbon footprint of different products, to analyze LCA report based on analysis of different product methods.

1.5. Research Objectives

The objective of this research is to develop a standard to obtain the best results out of the data provided by the suppliers/vendors to know the best product which is sustainable and emits a minimum amount of carbon footprint during the entire life cycle. The case study at KPN will be used to create and analyze the products based on empirical data obtained from different suppliers and based on interview conducted with the suppliers. Based on the research problem define in section 1.3 and the research scope define in section 1.4, the research objective is formulated as the following.

How to optimize the information received from the suppliers for the key products and analyze different LCA methodologies and based on analysis of different LCA, recommend the supplier to use one methodology.

1.6. Research Questions

The main research question for this research paper follows from the research objective as described in section 1.5:

How can we optimize the insights received from the suppliers/vendors to lower supply chain emissions towards net zero carbon emission in the supply chain?

Based on literature analysis the following sub-questions are formulated in order to answer the main research question.

1. What are scope 1,2 and 3 emissions?
2. Scope 3 emission and categories in scope 3 emission?
3. Importance of suppliers in scope 3 emission?
4. What insights are available for the industry to achieve targets?
5. What is the best way to achieve information about a particular product?
6. Why LCA's are important for scope 3 emissions?
7. Defining the LCA model?
8. What all LCAs are available?
9. LCA's analysis result and recommendation?

1.7. Research Approach

This research focuses on products, LCA of key products, and LCA tool used to get LCA report which suppliers provide to the parent organization who is seeking to achieve net zero carbon footprint. Since a case study is conducted, the case study methodology is used for this research paper. This case study methodology is combined with a process qualitative analysis (standardized approach) to form the research approach and semi-structure interviews will be conducted to formulate a final result.

1.7.1. Case Study Research

As the main structure of this research, the Case Study Research methodology ***("Jan Dul and Tony Hak. Case Study Methodology in Business Research. Elsevier LTD, 2017. ISBN 9780750681964")*** will be used as a backbone. According to a literature review, the case study has two main distinctions:

- Organizational approach
- Product based approach

According to the literature analysis included in the Case Study Research technique. Description research is more frequently practice-focused (65%) than theory-oriented (31%), or theory-testing oriented (4%). The creation, execution, and assessment of a theory in a firm and scenario are described in practice-oriented research. The goal of theory-oriented research is to contribute to theory building by studying examples of the study's object.

This research will use a practice-oriented approach where we will analyze the data provided by the KPN and we will conduct several interviews with the key suppliers of KPN in network, B2B and B2C domain.
The theory-oriented framework for the Case Study Research is shown in Figure 1.5

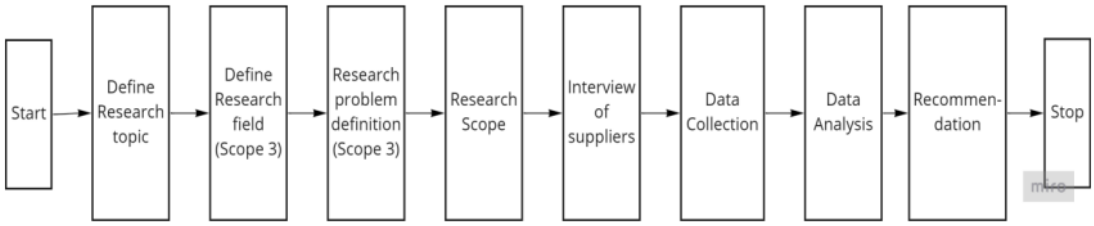


Figure 1.6: Case study Research step-wise approach

This case study-based research consists of an product -based approach to various data provided by the vendors in relation to scope 3 emissions.

The theory-building oriented case study methodology states that the aim of data analysis is to conclude about:

- The comparison of LCA data
- The product-based data availability
- To compare different LCA tool
- Standardize the inputs from vendors to deal with scope 3 emissions

1.7.2. Conclusion approach

This research will combine the case study research methodology, the interview-based approach, and data-based analysis. The research approach with its corresponding chapters is visualized in figure 1.6

1.8. Data Collection

The data will consist of different sources. First of all, understanding of the data required for scope 3 emission will be gathered from the literature. Earlier literature and research will be used to get an understanding of the scope 3 emissions and LCA report will be analyzed for further comparison of different products.

In the case study phase of research, data will be collected from different suppliers of KPN after interviewing them. All the data from data systems will be combined with observations, measurements, and interviews.

1.9 Structure of the thesis

Figure 1.7 explains about the *Structure of the thesis*

Chapter 01: Chapter 01 discuss about the introduction of the thesis, which includes research context, research field, research definition, research scope, research objective and research approach.

Chapter 02: Chapter 02 discuss about the literature review of the research topic and previous research on the topic related to scope 3 and LCA.

Chapter 03: Chapter 03 tells us about the theory related to research topic and other related research in the past focused on scope 3 emissions.

Chapter 04: Chapter 04 deals with methodology and analysis of products based on characteristic of the products. We have also discussed about semi-structure interview in the same chapter under methodology.

Chapter 05: Chapter 05 deals with applying the methodology to the KPN case study and research question.

Chapter 06: Chapter 06 deals with the conclusion of the research thesis with providing some limitations and finally recommendations for future research.

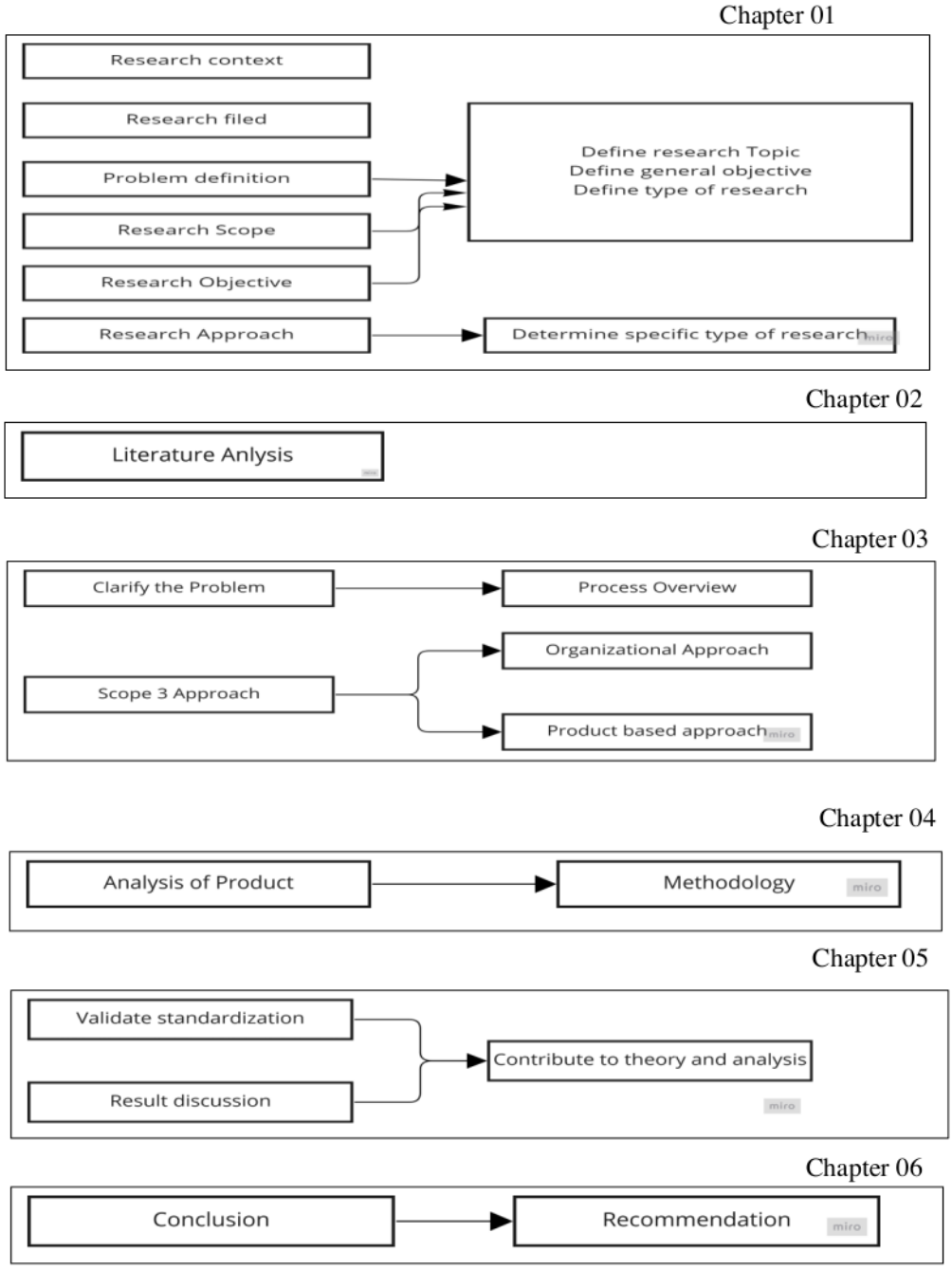


Figure 1.7 Research structure

2

Literature Analysis

In the previous chapter, the research was introduced and an overall understanding was given to understand the key problem related to scope 3 emissions and the constraints to achieve that. The main problem is lack of inputs available from the suppliers and optimizing those inputs to achieve carbon neutral in scope 3 emissions.

This chapter focuses on the theory needed to create a model that can be used to optimize the inputs provided by the suppliers concerning scope 3 emissions. To create this framework, analysis has to be done in general and within KPN Energy and Environment. Furthermore, process improvement theories for considering scope 3 emissions are studied and serve as a basis for the research. Finally, this chapter presents a control framework for the related theory of scope 3 emissions.

The following sub-research questions will be answered in this chapter:

1. Brief description of Scope 1,2 and 3 emissions?
2. Scope 3 emissions and categories?
3. Importance of scope 3 emissions in net zero CO_2?

2.1. Previous Research

As stated in the previous chapter, research has been conducted on scope 3 emission. Chronically, Edgar G. Hartwick in his research *on "The growing importance of Scope 3 greenhouse gas emissions from industry"* were he stated that scope 3 emissions associated with other inputs and investigated the indirect emission for scope 3 emission ***(Hertwich, The growing importance of scope 3 greenhouse gas emissions from industry, 2018)***. Many organizations refer to carbon footprint protocols for guidance on measuring their greenhouse gas emissions, or carbon footprint. Existing protocols generally require estimation of direct emissions (Scope 1) within organization.

Emissions from direct purchases of energy (scope 2). But focus less on indirect emissions upstream and downstream of the supply chain (Optional Scope 3). “As on average more than 75% of an industry sector’s carbon footprint is attributed to scope 3 sources, better knowledge of scope 3 footprints can help organizations pursue emissions mitigation projects not just within their plants but also across their supply chain “***(Y. Anny Huang, 12th October 2009)***. “According to the leading GHG Protocol corporate standard, a company’s greenhouse gas emissions are classified into three scopes, scope 1 and 2 are mandatory to report, whereas scope 3 is voluntary and the hardest to monitor”. However, companies succeeding in reporting all three scopes will gain a sustainable competitive advantage ***(Bernoville, 12th June 2022)***.

Previous research has been conducted in the form of importance of scope 3 greenhouse gas emissions from industry. The previous research scope was all regarding the importance of scope 3 emissions Edgar G Hartwick has shown the importance of scope emissions using the EXIOBASE 3.4 MRIO model, describing the world economy disaggregated into 200 products produced and consumed in 43 countries. In the paper of Y. Anny Huang has formulated to categorize the scope 3 emission based on emissions input-output life cycle assessment to observe the impacts of production activities by any sector in the economies.

1. [25th April 2018] Edgar G Hartwick and Richard wood: The growing importance of scope 3 GHG emissions from industry.
2. [17th January 2022] Julia Schrijvers: Introducing sustainability criteria in tenders with logistic service providers to reduce scope 3 emissions.
3. Y. Anny Huang, Christopher Weber: Categorizing of scope 3 emission for streamlined Enterprise Carbon Footprint. (Part of chapter 02)

2.2 Scope of Emissions

Within the GHG emissions which originate from different sources and to the carbon footprint assessment service analyzes, measures, and records three types of emissions that contribute to a company's carbon footprint as specified by the GHG Protocol.

2.2.1 Scope 1 emissions

“Scope 1 emissions are direct emissions from company-owned and controlled resources. In other words, emissions are released into the atmosphere as a direct result of a set of activities, at a firm level. It is further divided into four categories: stationary combustion (e.g., fuels, heating sources). All fuels that produce GHG emissions must be included in scope 1” ***(Balabasqer, 29th September 2021)***.

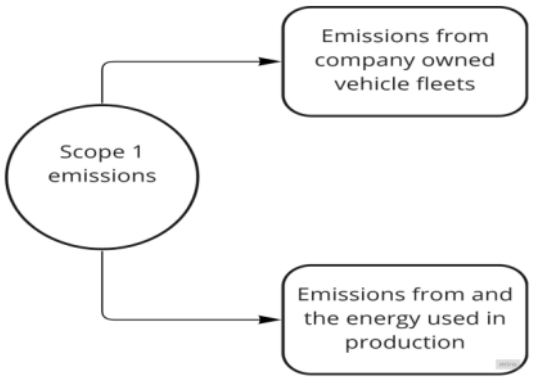


Figure: 2.1 Scope 1 emission

Scope 1 emission includes all emissions generated directly by the company and its activities in factories, facilities, warehouses, offices, and vehicle fleets owned by the company itself.

2.2.1 Scope 2 emissions

Indirect emissions – owned, when an organization purchase electricity, which generates greenhouse gases while being produced at a coal or natural gas plant, power plants comes under Scope 2. These are indirect emissions from the generation of energy purchased by a company from a utility provider. This means that all GHG emissions released in the atmosphere, from the consumption of purchased electricity, steam, heat, and cooling come under the umbrella of scope 2 emissions **(Balabasqer, Measuring your GHG emissions scope 1 ,2 and 3 , 29th Sepetmber, 2021).**

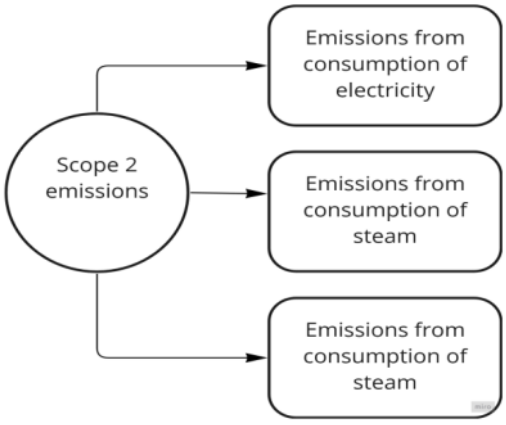


Figure: 2.2 Scope 2 emissions

2.2.3 Scope 3 emissions

Scope 3 emission corresponds to all the indirect emissions taking place upstream or downstream in the company's value chain even if they are not directly generated by the organization, it is easy to understand that they are no less necessary for its activity. They are often poorly optimized and

therefore often have a reduction potential that is often easy to obtain, hence the importance of analyzing and measuring them precisely is not formulated yet. However, their measurement is not always easy the priority being to focus on the major emissions heading, which is the large Tier 1 supplier, and those associated with upstream and downstream transport ***(emission, 2019).***

Generally speaking, the most significant Scope 3 emission is a very significant heading, generally much higher than scopes 1 and 2.

- Emissions from its direct suppliers, and throughout the value chain of its product.
- Emissions related to upstream transport, and those related to downstream transport and distribution.
- Finally, one item that can be very significant in certain sectors is the emissions related to the use of a product throughout its lifecycle. However, this heading is different from the others, it goes without saying that, in general, the energy efficiency of a product is directly linked to the quality and design of the products ***(emission, 2019)***.

Measuring Scope 3 emissions are also an important factor for the organization to know their carbon emissions in their value chain as for many organizations the majority of their greenhouse gas (GHG) emissions and cost reduction opportunities lie outside their operations.

Scope 3 emissions are the indirect emissions for an organizations, which originates from different supplier that occur in the value chain of the reporting company, including upstream and downstream emissions. An organization should measure their scope 3 emissions for the following reasons:

- To know the supply chain emissions hotspot in value chain.
- Recognize the energy source and risks in supply chain.
- Recognize energy efficiency and cost reduction opportunities in their supply chain.
- Working towards improving energy efficiency of their products.
- Engaging employees to reduce emissions from business travel and employee commuting ***(A guide to net zero for businesses , 2019)***.

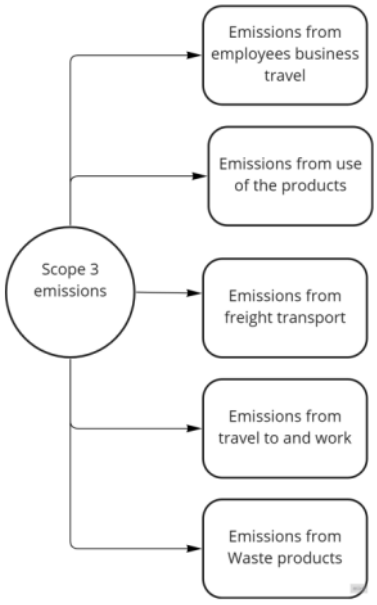


Figure: 2.3 Scope 3 emission

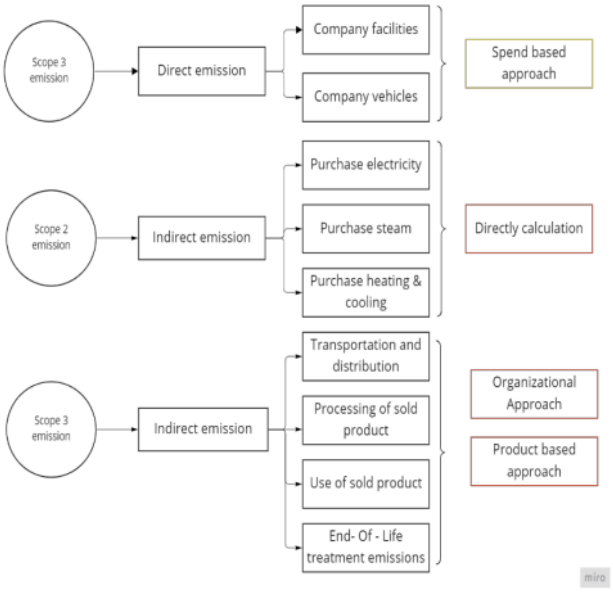


Figure: 2.4 Scope 1,2 and 3 distribution

2.3 Scope 3 emission and categories

Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting organization, but that the organization indirectly impacts in its value chain. Scope 3 emissions include all sources not within an organization's scope 1 and 2 boundaries. The scope 3 emissions for one organization are the scope 1 and 2 for another organization. Scope 3 emissions, also

referred to as value chain emissions represent the majority of the emissions for an organization's total GHG emissions ***(agency, 12th May 2022)***.

Scope 3 emissions are the indirect emissions for an organization that deals with all the Product life cycle from manufacturing till end-of-life. Scope 3 emission fall within 15 categories, though not every category will be relevant to all organizations. Scope 3 emission sources include emissions both upstream and downstream of the organization's activities.

Every organization reporting scope 1 and 2 must quantify scope 1 and 2 emissions when reporting and disclosing GHG emissions, however scope 3 emission quantification is optional. More firms, however, are delving further into their value chain to determine the complete GHG effect of their activities. If a company wants to reach net zero carbon footprint, they must concentrate on reducing scope 3 emissions, and they frequently provide emission reduction options. Although these emissions are outside the organization's control, the organization may be able to influence the actions that cause emissions but only up to an extent. The organization may also be able to influence its suppliers or select vendors depending on their practices ***(agency, 12th May 2022).***

2.3.1 Scope 3 emission categories

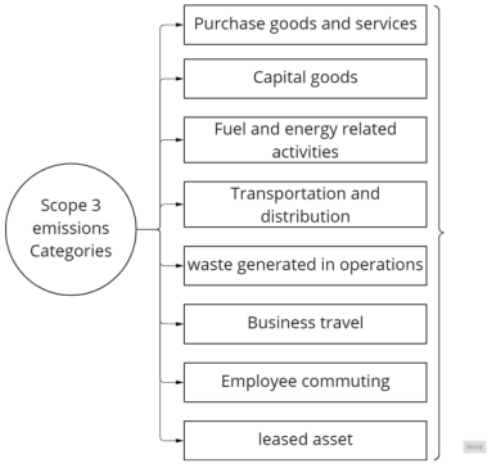


Figure 2.5 Upstream scope 3

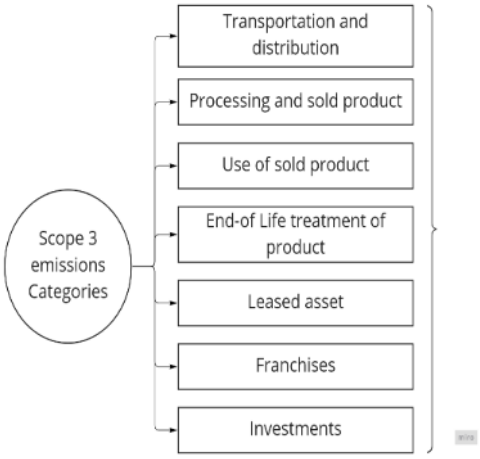


Figure 2.6 Downstream scope 3

For scope 3 emissions, which consists of upstream (Figure: 2.1) and downstream emissions (Figure 2.1) for an organization where calculating each category is relatively difficult because of the scarcity of the data availability. Organizations should select calculation methods for each scope 3 activity within the category based on the following criteria.

- The relative size of emissions from scope 3 activity
- The organization's business goal
- Data availability
- Data quality
- The cost and time frame required to apply each product
- Other criteria identified by the company

For the organization to ask for data from the vendors will be a relatively very strenuous task to meet the requirement as evaluating scope 3 emissions enables companies to identify the greatest GHG reduction opportunities across their corporate value chain, and in turn make more sustainable decisions regarding their company's activities and the products they buy, sell, and produce.

2.4 Conclusion Literature Analysis

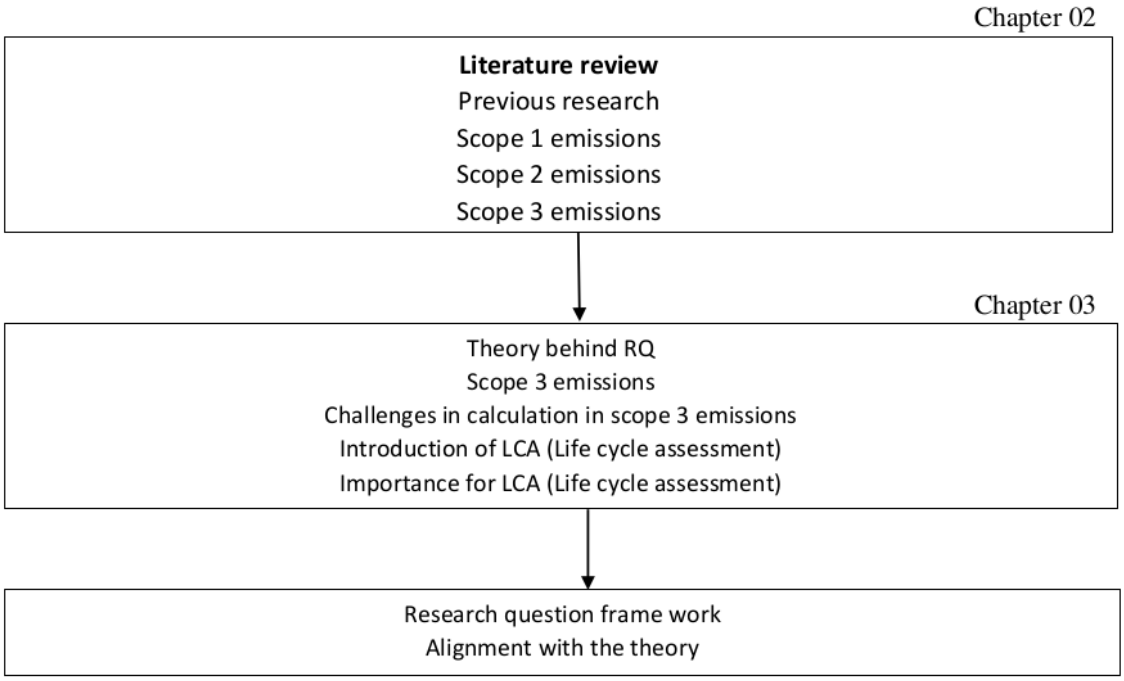
This chapter discussed previous research, current scenarios on Scope 3 emissions, and challenges for the organization to calculate Scope 3 emissions having 15 different categories were getting data for each of the categories is not possible we have also shown that categories are subdivided into upstream and downstream emissions.
In this chapter the following research questions are answered:

1. What are scope 1,2 and 3 emissions?

2. Scope 3 emissions and categories of Scope 3 emissions?

3. Importance of Scope 3 emissions?

Figure 2.7 (Structure for chapter 02 and chapter 03 for RQ)



3

Scope 3 Emissions & LCA

In the previous chapter we have shown previous research conducted on scope 3 emissions and we have also analyzed literature to get characteristics that can be used to define emissions distinguished based on scopes. Finally, chapter 02 concluded with the structural framework for scope 3 emissions from the literature that can be used in the case study.

This chapter is interlinked to chapter 02 and gives the main theoretical study based on environment and sustainability related to scope 3 emissions. The main processes that are important to calculate scope 3 emissions. This chapter also include in-depth analysis of Scope 3 emissions and challenges in calculations of scope 3 categories. This information is backed up by literature from different research on the same topic. To understand Scope 3 emission, we have formulated a flow chart where we have shown how uncertain it is to collect data from the suppliers/vendors. To understand Scope 3 emissions performance of an organization needs to describe and KPIs are described in the scoreboards, this chapter describes the pillars of scope 3 emissions. This chapter will also describe the importance of LCA (Life cycle assessment) in scope 3 emission and why is it relevant to do an LCA comparison and how should we optimize the supplier's input for scope 3 emissions to meet our goal of net zero carbon footprint.

The following sub-research questions will be answered in this chapter:

1. Scope 3 emissions?
2. LCA related to scope 3 emissions?
3. Importance of LCA in scope 3?
4. Insights available from suppliers?

3.1. Scope 3 emissions

In this chapter we are focusing more on GHG (Green House Gas) protocol for calculating scope 3 emissions and GHG protocol product standards were both takes a value chain or life cycle approach to GHG accounting and were developed simultaneously. The scope 3 emission describes value chain emissions at the corporate level, while the product that the organization receives accounts for life cycle emissions at the individual product level. Both the corporate standard and product life cycle assessment provide a comprehensive approach to the value chain GHG measurement and management.

The reporting companies who are reporting their GHG emissions should drive the particular GHG reporting standard. However, for the organization the Scope 3 emission standard enables a company to identify the greatest GHG reduction opportunities across the entire corporate value chain, while the product-based emission standard enables a company to target individual products with the significant potential for reductions in GHG emissions. For a company to reduce its GHG emission, track its performance and engage suppliers at the corporate level scope 3 standard plays a vital role. While the product standard helps a company meet the same objectives at a product level.

"For the companies to calculate scope 3 emissions common data is used to develop scope 3 inventories and product inventories, including data collected from suppliers and other companies in the value chain" ***(Pankaj Bhatia, 2018)***.

Each standard has to be implemented independently. However, for the organizations to apply the standards are mutually supportive.

- Applying the scope 3 standards, after fetching the result identify the products with the most significant emissions, then use the product standard to identify products that are more hazardous to the environment.
- Using product-level GHG data based to calculate scope 3 emissions.
- Applying either the scope 3 emission or the product standard and using the results to inform GHG-reduction strategies that reduce both product and corporate level (Scope 3) emissions.

For an organization, the sum of emissions, combined with additional scope 3 categories such as employees commuting, business travel by employees, and investment the sum of the total would approximate the company's total corporate GHG emissions.

$$\text{Total emissions} = \sum Scope\ 1 + Scope\ 2 + Scope\ 3$$

Figure 3.1 illustrate the relationship between the corporate standard, product standard and scope 3 standard

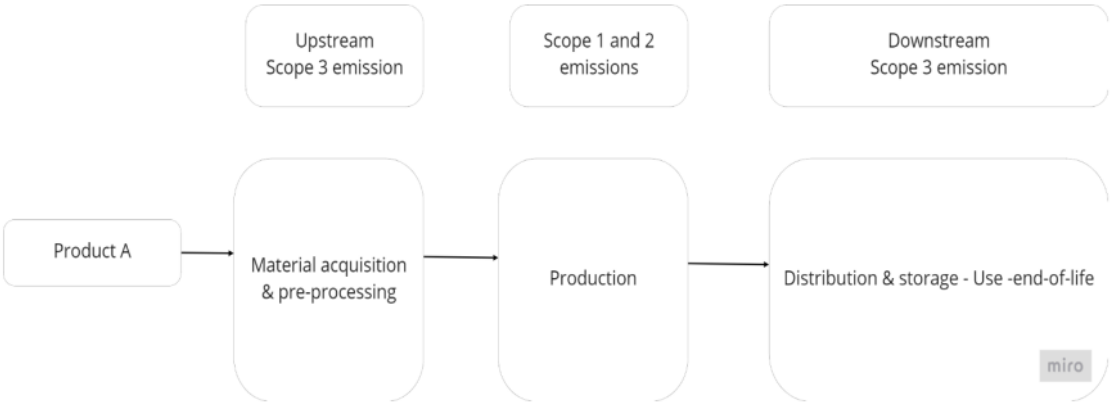


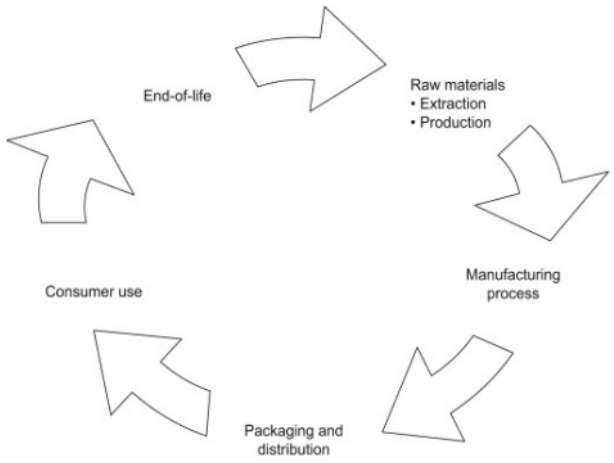
Figure 3.1: Corporate standard, Product standard and Scope 3 standard

Figure 3.1 shows in the simplified example, that a company manufactures product A. The figure 3.1 shows how scopes of emissions at the corporate level correspond to life cycle stages at the product level.

In further topics in this chapter, we will discuss LCA (Life cycle assessment) we will introduce this topic with a structural approach for LCA.

3.2. Life Cycle Assessment (LCA)

"Life cycle assessment (LCA), sometimes referred to as life cycle analysis, measures the impacts on the environment associated with the life cycle of a product, process, or service Every part of a product's life cycle – extraction of materials from the environment, the production of the product, emission during use phase and emissions from the product after it is no longer used – can have an impact on the environment in many ways These parts of a product's life cycle are called life cycle stages With LCA, we can evaluate the environmental impacts of our products or service from the very first life cycle stage to the very last or any life cycle stage in between" ***(Golsteijn, 17th July 2020)***.



Life cycle analysis can be performed for various scopes: cradle to gate (raw material until factory gate), gate to gate (only focusing on the manufacturing processes from manufacturing unit till retailer), or cradle to grave (emissions from raw material extraction until to disposal).

3.3. Importance of LCA

There are many benefits of a LCA report, which consists of report related to product components and components which are environmentally hazardous. LCA report consists of percentages of components contributes in total carbon footprint during entire life cycle. LCA also helps in product development, marketing, strategic planning, and even policy-making. For example, Product designers can help in manufacturing a more sustainable and circular product. The organization that is working towards carbon neutrality can use LCA report to know about the purchased products, which they are procuring from different organizations. Sustainability managers can assess the portfolio and see what's needed to achieve carbon neutral goals. A purchasing team can learn which suppliers have the most sustainable products.

3.4. Four steps of life cycle assessment

LCA is a standardized tool, which makes it reliable and transparent. The International Organization for Standardization (ISO) provides standards for LCA an ISO 14040 and 14044. These standards describe four main phases of an LCA:

- Goal and scope definition
- Inventory analysis
- Impact assessment
- Interpretation

LCA is a methodology, where an organization can refine things as go along with the LCA process for instance, the first round of exercises will tell us where you need more data for the LCA report

"Or the results of the assessments or your interpretation may nudge you to revise your scope and goal" **(Golsteijn, 17th July 2020)** . Hence, Every LCA tells us about the product and how to enhance our product eco-friendlier and more sustainable.

Figure 3.2 LCA step-by-step process

The four stages of LCA contribute in many several ways such as product-related development and improvement, Strategic planning, Portfolio assessment, Organizational footprint and capacity building, and knowing well about their value chain.

3.5. Scope 3 emissions calculation

For the organization calculating Scope 3 emissions could be done by two ways:
1. Spend-based method
2. Average-based method

3.5.1 Spend-based method

The spend-based method takes the financial value of a purchased goods or services and multiplies it by an emission factor – the number of emissions produced per financial unit – resulting in an estimate of the emissions produced. In this method, the amount spent on any purchase (for example upstream transportation of product) by type is multiplied by the relevant EEIO emission factors. Refer to "Environmentally-extended input-output (EEIO) data" in the introduction for guidance on EEIO data.

- Amount spent on purchase by type (e.g., rail, road, air, barge.) using market value.

Emissions factor needed:

- For upstream emissions, Cradle to gate emissions factors of the transportation type per unit of economic value (e.g., kg CO_2 e/ €)

Spend-based method calculation:

CO_2e emissions = sum across purchase (for example transportation) $\sum(amount\ spend\ on\ purchase)$* relevant EEIO emission factors per unit economic value (kg CO_2 e/€)

3.5.2 Average-data method

Average based-data method comes into the picture when there is no sufficient data to calculate scope 3 emissions where supply-chain specific data is not available in that case companies should collect average emission factors for distribution activities.

- The volume of purchased goods that are stored.
- The average number of days that goods are stored.

"Emissions factor needed:

- Emissions factor/ product stored in the facility
- Emission factor per square meter or cubic meter stored at the facility
- Emission factor /TEU stored at the facility" **(Pankaj Bhatia, 2018).**

Average-data method (distribution)

$$CO_2e\ emissions = \sum(vaolume\ of\ stored\ goods\ (m^3) * Average\ no.of\ days\ stored * emission\ constant\ for\ facility\ (Kg\frac{co2e}{m^3})$$

Using the spend-based method and Average-based method we can calculate the emissions by 15 categories (i.e., 15 categories for scope 3 emissions). However, calculating all the 15 categories requires a lot of data collection from different vendors in both upstream and downstream emissions. However, LAC consists of all the categories within and calculates emissions from manufacturing till end-of-life.

3.5.3. Drawback of using above mentioned methodology

As we can see the above-mentioned methodology can be used for calculating each category of scope 3 emissions. However, we required data from our previous supplier to calculate each category. For each category we can calculate the emission provided availability of data if the supplier can provide it. However, many a time the supplier doesn't keep a record of the data required for the calculation. Calculating Scope 3 emissions categories as shown in chapter 02, figures 2.1 and 2.2 upstream and downstream emissions, will be a clumsy job as the supplier will not be able to provide the relevant data. In the next section, we are going to perform a **SWOT** analysis for the methodology mentioned in the previous section.

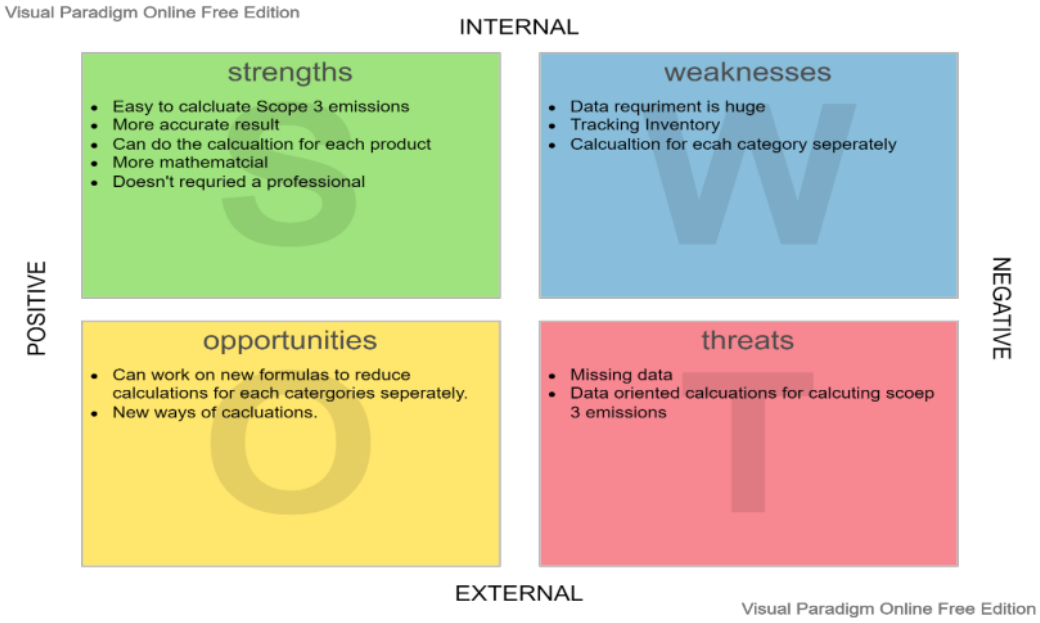


Figure 3.3: ***SWOT Analysis***

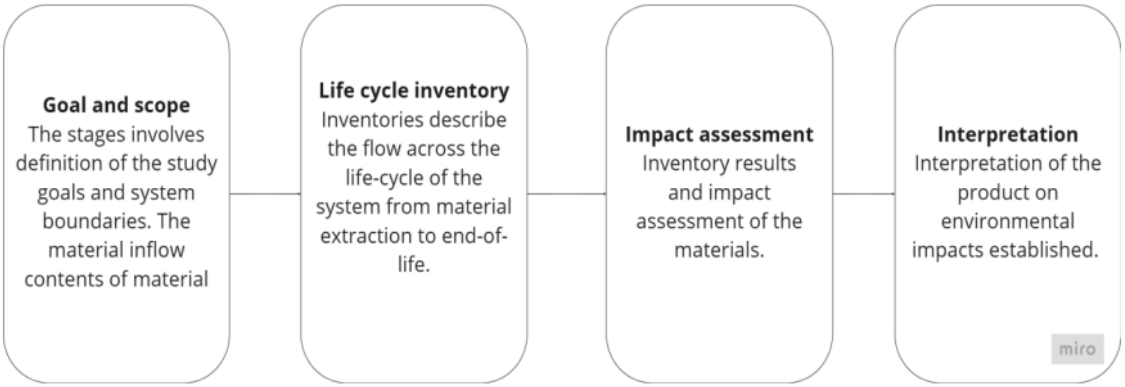
3.6. Product-based approach ("Related to LCA")

Life cycle analysis is a powerful method to quantify impacts based on the content of a product used to manufacture a product. The result of the LCA exercise provides you with all types of emissions from cradle to grave.

Raw material extraction - Production – Transportation – Use phase – End-of-life

"In addition to that, the endpoint impact analysis also provides quantitative results of general environmental impact assessment which is possible to be written as additional results and deeper analysis in government or company environmental report" **(A P Iswara, 2020)**.
Many types of software can be used for impact analysis, for example, SimaPro, Open LCA, Gabi, etc. Life cycle assessment (LCA) covers all 15 categories for scope 3 emissions in four steps.

Figure 3.4 shows all 4 steps covering 15 categories for scope 3 emissions.



The four steps of LCA cover all 15 categories of scope 3 emissions, which include upstream and downstream emissions. All the LCA steps are standardized under ISO such as step first goal and scope study are (defined by ISO 14040); Inventory analysis of LCA where we define product life cycle inventory is (defined by ISO 14041); Impact assessment understanding the environmental relevance of all inputs and outputs is defined LCIA(Life Cycle Inventory Assessment) is under ISO 14042; Interpretation of the study is defined by ISO 14043.

3.7. Comparison between the phases of an ISO LCA study and the steps of a product standard GHG inventory

Phases in an ISO LCA study	Steps in a production standard GHG inventory
Goal and scope definition	Business goal (Chapter 2),Principles (chapter 4),fundamentals of product life cycle accounting (chapter 5),defining of scope (chapter 6).
Inventory analysis (LCI)	Boundary settings (Chapter 7),data collection and quality assessment (Chapter 8),allocation (chapter 9)
Impact assessment	Calculation inventory result (Chapter 11)
Interpretation	Uncertainty (Chapter 10) Performance tracking (chapter 14) reporting (Chapter 13)
reporting and critical review	assurance (chapter 12) reporting (chapter 13)

Source: GHG Protocol Product life cycle, page no: 24-25

The life cycle approach is by nature an iterative technique, where each phase or step is independent of the formulas or the result used in the previous sections.

3.8. Research context

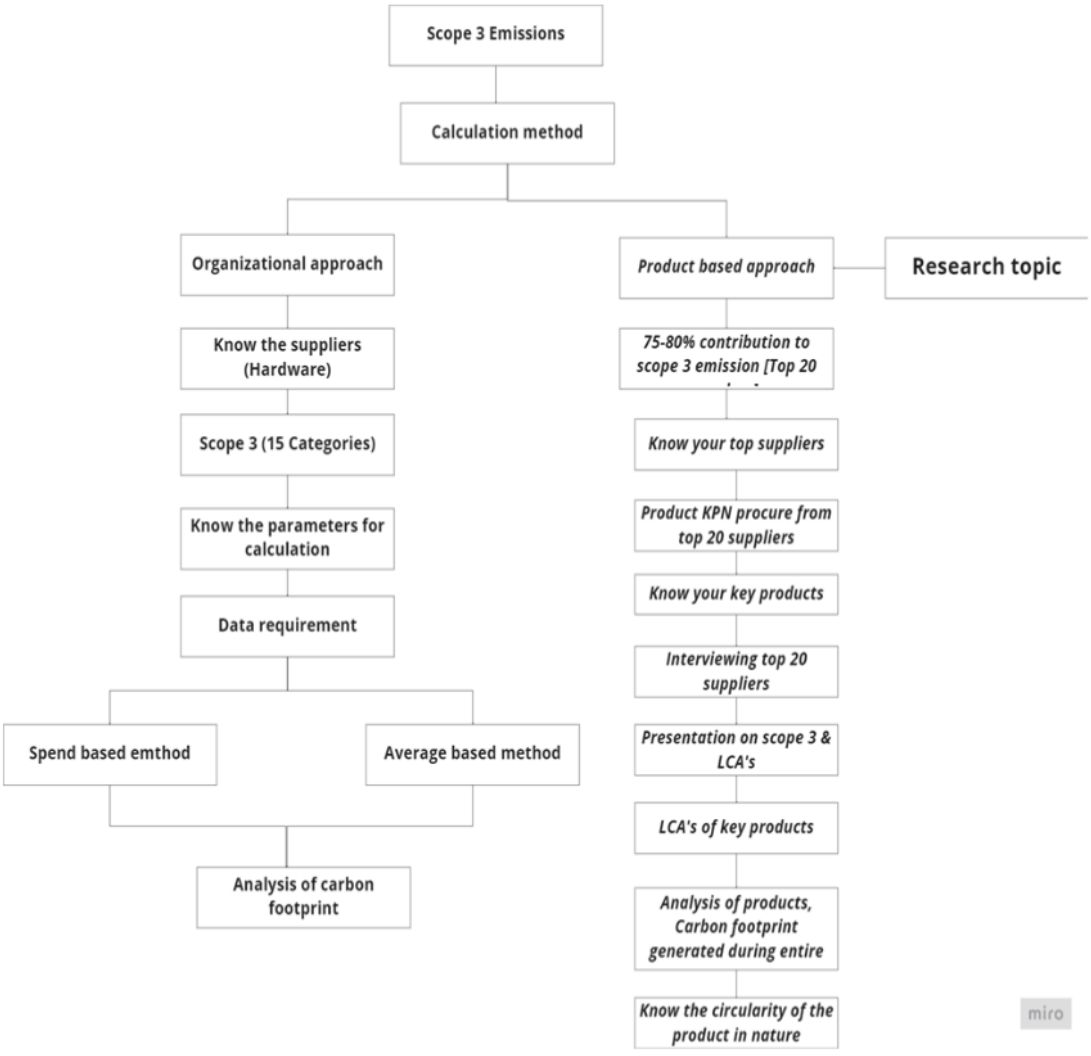
For calculating Scope 3 emissions because of the above-mentioned drawbacks, organizations are switching from an organizational-based approach toward a product-based approach which includes LCA's of the products. In this research, we are trying to optimize the insights available from our key suppliers and compare two different types of LCAs and provide them with pros and cons based on our analysis we will recommend the specific LCA to use.

3.9. Conclusion of Scope 3 and LCA's

This chapter gives an overview of Scope 3 emissions categories, factors important for LCA and 15 categories of Scope 3 emissions and how it is correlated to life cycle assessment (LCA). The

importance of life cycle assessment (LCA). We have also defined the two methodologies that are being used by the organization and the drawback of using those methodologies. We have shown a comparison of LCA steps with the GHG protocol categories. The product-based approach of life cycle assessment (LCA) and its importance to know the total carbon footprint of a product during entire life cycle. After providing with literature review and the theory behind the research question we can formulate a block diagram to show the process of optimizing the insights available from the suppliers in context of product received from different suppliers.

Figure 3.5 shows the structure and framework for answering the research question



4

Methodology & Data collection

In this chapter, we will discuss the methodology and analysis of the core problem in the telecom industry. This chapter is further divided into 4 sections each section will consist of an analysis and a problem statement. We will introduce the KPN current situation for Scope 3 emission, the background of the problem statement, the data collection method which is mainly document based, and an analysis of LCA's in this paper we are comparing two broadly used LCA used by the majority of the organization. The literature framework has been created in chapter 3. The goal of this chapter is to give background information on the current state at KPN for measuring Scope 3 emission and providing with methodology we have used to answer main research question.

First, the KPI performance indicator is measured. Then an analysis is made for the current approach and the product-based approach. Furthermore, we are going to set parameters to compare two LCA tool currently used by the majority of organizations i.e., SimaPro and GaBi.

4.1. Background

Today's efforts to tackle climate change have emphasized the critical role of renewable energy and energy-efficiency measures. However, meeting climate targets will also focus on tackling the remaining 45% of emissions which is generated in manufacturing products. A circular economy offers a systematic and cost-effective approach to tackling this challenge. As we can see from figure 4.1 which shows 55% of emission is from the energy phase during the use phase of the particular product, we will discuss more this topic in the next section. 45% of the emissions are from products if we manufacture products that are made up of recyclable material then we can reduce the emissions during the production phase. However, to reduce the total emission we have to consider both the scenarios i.e., emissions during the energy phase (use phase) and product level emissions.

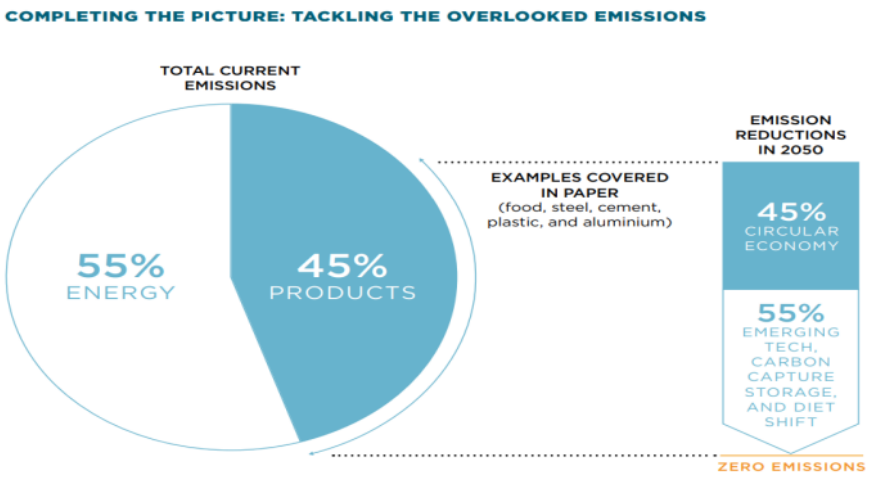


Figure 4.1: Total emission in energy and product phase (Source: KPN climate change)

At present, KPN is using a hybrid calculation methodology.

78% spend based method > spend categories * emission factor

However, for KPN the current investigation is for the calculation of emissions applying (standard) product LCA to calculate emissions per product and product family. In the upcoming section in this chapter, we will discuss the step-by-step process to optimize the inputs from the vendors to calculate scope 3 emissions. We will also discuss the organizational approach and product-based approach which we have already discussed in the introduction of the case study approach which is a practice based. As we have formulated earlier in the previous chapters the importance of scope 3 emission in total carbon footprint reduction. As we can see from figure 4.2 which shows a bar graph showing the emissions for scope 1 and 2 for an organization is very less as compared to the emissions related to scope 3 where the emissions for the production phase is maximum. However, calculating the emission during the production phase could be a strenuous task. Hence, using LCA of a particular product for category 4 purchased and goods will be able to provide us with those data. LCA of each product which a company procures from the suppliers many a time not available we can go for LCA of the similar product having same type and purpose with having minor changes in the components.

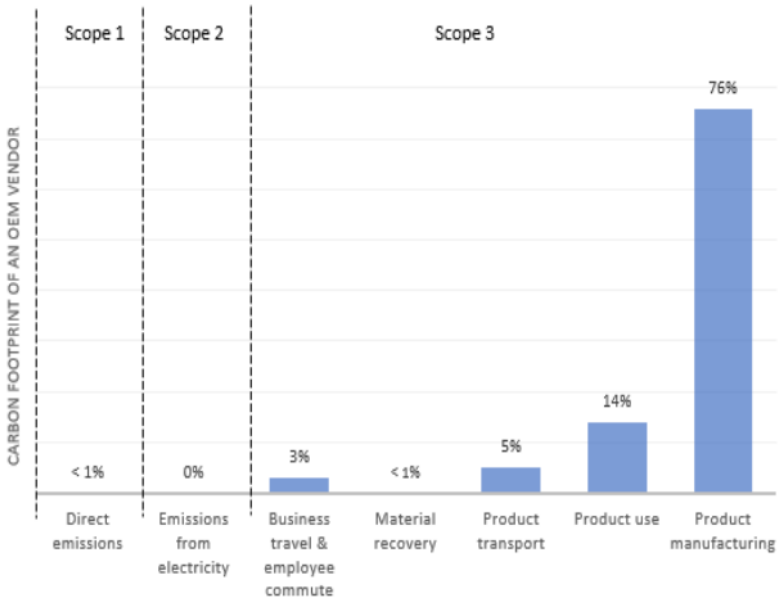


Figure 4.2: Scope 1,2 and 3 emissions in Apple's overall carbon footprint 2018.

4.2 Case study research

For the organization to achieve a net zero carbon footprint they mainly rely on the organizational approach where they approach the suppliers to get different parameters and calculate the emissions based on the spend-based method or average-based method. In this paper, we have taken a different approach i.e., Product based approach to knowing scope 3 emissions. In the upcoming sections, we are going to describe both the approaches and deep dive into the product-based approach with the main objective to optimize the insights available from the supplier for calculating scope 3 emissions. However, to optimize the insights available from the suppliers we have conducted a series of interviews with different suppliers after showing them a presentation based on product and environmental-related topics. The majority of organization is currently working on scope 3 emissions "As mentioned, under scope 3 emissions, category 1 (i.e., purchased goods and services) and category 11 (i.e., use of sold items) contribute to about 85% of global GHG emissions in the ICT sector, we aim to concentrate on scope 3, category 1 emissions (cradle-to-gate) in our study and look at the carbon estimation methodologies present in the ICT sector, both on the product (PLCA- Product Life Cycle Assessment) and corporate level (Spend-based method). To further understand the importance of scope 3 category 1 emissions in the ICT sector, figure 4.2 shows the emissions related to scope 1, scope 2, and scope 3 of one of the major companies in the ICT sector during the year 2018. It can be seen that the product manufacturing stage under scope 3 category 1 contributed to the CO2eq the most (76%) to the overall corporate emissions. OEM (Original Equipment Manufacturer) with a different product portfolio may have different trends" **(jha, 2022).**

4.3. Organizational-based approach

For organizational approach organizations generally follow the same trend as mentioned earlier in chapter 03. The organizational approach provides lots of data collection from vendors and within the organization for different categories of scope 3. Companies may see difficulties in justifying not taking responsibility for indirect emissions. "Scope 3 emissions do fall outside of the company's direct control/ownership. However, it is more difficult to collect scope 3 data, and the inherent control and ownership structure can create barriers to reducing these emissions. Indirect emissions are sometimes double or triple counted, with many companies' value chains significantly overplanning" **(Farsan, 2018)**. Within the company's value chain, upstream emissions are indirect GHG emissions related to purchased or acquired goods and services, capital goods, upstream transport and distribution, business travel, etc. These emissions span the scope of 3 categories 1 to 8 of the GHG protocol. The most significant of these stems from purchases of goods and services (category 1).

"Ways of reducing supply chain emissions can be reduced by one or more of the following at the organizational level.

- *Optimizing a company's production processes results in reduced demand for goods and services.*
- *Making different purchasing decisions to favor low-carbon products and services.*
- *Purchasing from suppliers with a low carbon footprint.*
- *Engaging the suppliers to reduce emissions across the value chain"* **(Farsan, 2018)**.

Organizational approach for calculating scope 3 emissions categories. The following categories are quite relevant for organizational approach.

- Category 1 - Purchase goods and services
- Category 4 - Upstream transportation and distribution
- Category 3 - Business travel
- Category 7 - Employee commuting
- Category 9 - Downstream transportation and distribution
- Category 11 - Use of the sold product
- Category 12 - End-of-life treatment of the sold product

For the company calculating category 3,7 is directly related to the organization whereas calculating the rest of the categories is indirectly related to the organization. Where the organization has to ask for different data from the suppliers to know the emissions of the product, which they purchase from different suppliers.

4.4. Product-based approach

The life cycle of a product is a subset of life cycle assessment (LCA), greenhouse gas accounting (GHG accounting) aims to measure and manage the environmental elements and possible

environmental repercussions across a product's life cycle, from raw material extraction to end-of-life waste disposal. The international organization for standardization (ISO), with the release of the 14040 series of life cycle assessment standards made LCA a global standard. The lifecycle of a product is a subset of life cycle assessment (LCA), greenhouse gas accounting (GHG accounting) aims to measure and manage the environmental elements and possible environmental elements and possible environmental repercussions across the product's life cycle, from raw material extraction through to end-of-life waste disposal. The release of the ISO 14040 series of life cycle assessments by the international organization for standards (ISO) led to the internationalization of LCA. The product life cycle gives a thorough understanding of material acquisition, distribution & storage, use phase, and end-of-life which all are summed in the GHG protocol under product life cycle.

The product life cycle consists of the following categories under GHG protocol.

- Category 1 (Purchased goods and services)
- Category 4 (Upstream transportation and distribution)
- Category 9 (Downstream transportation and distribution)
- Category 11 (Use of sold product) emissions using the sold product
- Category 12 (End-0f-life treatment) Emissions during end-of-life treatment

The GHG protocol scope 3 standard and GHG protocol product standard both take a value chain or life cycle approach to GHG accounting and were developed simultaneously. However, a product report (LCA) of a product provide us with about all the above-mentioned categories which are beneficial as compared to gathering data from the suppliers. The five stages of a product life cycle are shown below

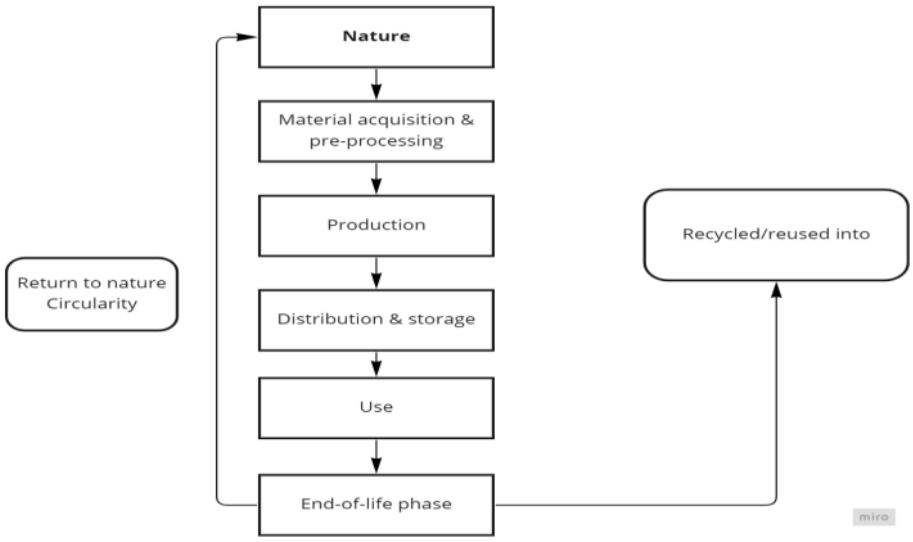


Figure 4.3 Five stages for product life cycle

Key product based on quantity, weight, and price (Based on analysis of products)

For defining scope 3 emission related to suppliers consists of manufacturing, transportation, use phase, and disposal.

For refining our strategy to get key products we are assuming that those products will make a bigger impact on the scope 3 emissions calculation if they are provided in a larger quantity and have greater weight.

Quantity: Quantity is one of the major factors to distinguish or the first step to know the major key products out of the number of products received. Out of all the products which we receive those products which are received in a greater number will be more environmentally hazardous unless those products are made up of 100% environmentally friendly or 100% recyclable materials for those kinds of products the eco burden will be really low. Recyclable products are also used in waste electricity generation as a by-product. Quantity of product is a major factor in scope 3 emission as it deals with product manufacturing till it is delivered to the end customer in some cases the end customer is a consumer and in some cases it's the service provider (i.e., KPN).

For example: if a company provides 5000 products the first step is to refine the product list based on the number of products (# no. of each product) that will make a bigger impact on the environment compared to a product that is available in quantity #01).

#No. of prodcuts	Quanity	Eco-burden	Total Burden
Article 1	100	1.45	145
Article 2	10	0.89	8.9
Article 3	5	0.75	3.75
Article 4	8	1.54	12.32
Article 5	4	1.88	7.52
Article 6	2	0.54	1.08
Article 7	1	0.45	0.45

Figure 5.5 product quantity and Eco-burden (Provided by Huawei)

Figure 5.5: Shows that the article (i.e., Product) corresponds to quantity and eco-burden.

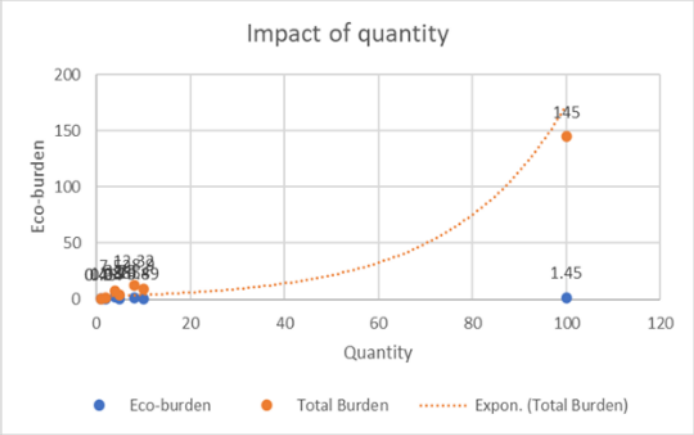


Figure 5.6 Quantity vs Eco-burden

Figure 5.6: Shows the exponential growth of the eco-burden with increasing quantity corresponding to even lesser eco-burden.

Weight: Weight is another important factor to know the impact of products on the environment. For analysis of scope 3 emission, we have considered the key products based on weight. The product having a higher weight will consist of a large number of components as compared to a product that is lighter in weight. However, products that are lighter in weight may consist of component which is more environmentally hazardous as compared to products that are manufactured using many components. As well as it is important to notice weight is not only a factor that tells us about the carbon footprint. it is a wrong assumption to consider that if the product weight is on the higher side the carbon footprint is more. For example: for any product which is quite heavy (w=mg) the product doesn't need to have higher carbon emission it will have higher carbon emission in the production phase but lesser in the Use phase. Similarly, other products such as servers will have lower carbon emissions during the production phase but higher during the use phase (Dell product carbon footprint: https://www.dell.com/learn/ie/en/iecorp1/corp-comm/environment_carbon_footprint_products Accessed on: 20/09/2022)

Price: We have not considered price as one of the factors for key products as price is not an independent factor it fluctuates on many other factors such as Inflation, Political issues, and Trade war (for example between USA and China). Having said that we have concluded the price should not be the important factor in analyzing the key products.

4.5. Characteristics of products

Products in the telecom industry are classified into three main categories that are:

1. Network equipment
2. Customer premises equipment
3. Device for customers.

Products that are used in network equipment are mainly used for providing networks such as antennas, modems, Access points, and bridges. However, different products within the telecom industry have different emissions during the life cycle.
In network equipment, the emissions during the use phase are maximum as compared to during raw material extraction and transportation and production that is because the network equipment serves the purpose of providing a network no matter what hence for network-providing equipment the emissions are maximum during the use phase. *CPE (Customer premises equipment)* and for devices (Mobile phones) the emissions are way different because both products serve different purposes. CPE is used only for providing the main purpose such as Telephone handsets, Cable set-boxes, and digital subscriber line (DSL) routes that is why for CPE products the emissions are uniformly distributed between raw material extraction and use phase. However, for a device such as (Mobile phone, or iPad) the emissions are not uniformly distributed because it required lots of components for manufacturing a phone which is why the emissions are maximum during the raw material extraction phase as compared to the production phase and use phase.

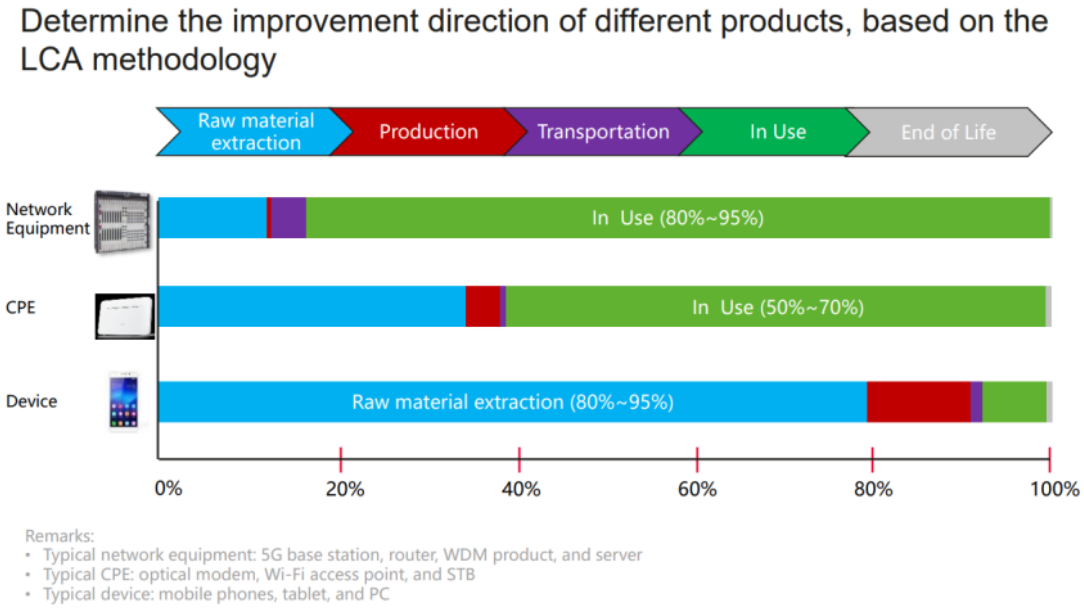


Figure 4.4 Products emissions during different phases (Huawei product report 2021)

4.6. Research Approach

In this research paper, we have followed ***qualitative research methodology*** "which is considered to be suitable when the researcher or the investigator either investigates a new field of study or intends to ascertain and theorize prominent issues" **(Corbin J, 2007)** . "Many qualitative methods are developed to have an in-depth and extensive understanding of the issues using their textual interpretation and the most common types are interviewing and observations" **(JW, 2007).**

4.7. Data Collection

In this section, we will discuss the data collection strategy. In this research paper, we have formulated two ways of data collection the first one is secondary data collection which is based on data collected from different sources such as data collection within the KPN and data collection from suppliers and the second one is primary data collection where we have conducted semi-structured interview with different suppliers.

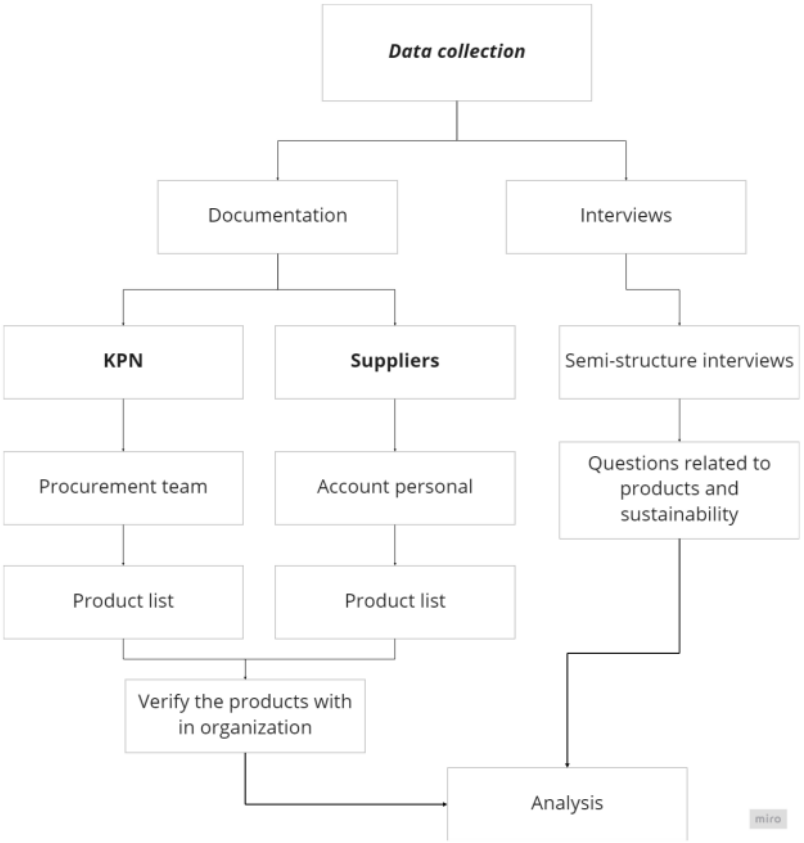


Figure 4.5 Data collection structure

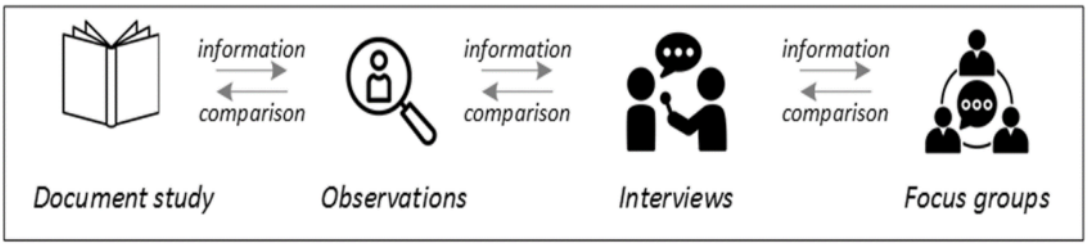
4.7.1. Secondary data collection

Secondary data collection is based on data that consists of a product list that we have received from the procurement team within KPN. We have also contacted different suppliers for the same to obtain the product list from last year January 2021 till march Q1 2022. We have documented all the product list separately which we have obtained from KPN and from key suppliers based on that list of products will get to know the key products. Based on the product analysis will be able to know which products can be more and less environmentally hazardous.

4.7.2. Primary data collection (Interviewing)

This is the most common format of data collection in qualitative research. According to **Oakley**, A qualitative interview is a framework in which practices and standards are not only documented, but also attained, questioned, and supported. As no interview lack's structure **(London, 1994)** most qualitative research interviews are either semi-structured, lightly structured, or in-depth. Unstructured interviews are often recommended while undertaking long-term fieldwork because they allow respondents to express themselves in their manner and at their speed, with little control over their comments. **(Corbin J M. J., 2003)**. Semi-structured interviews are in-depth interviews in which respondents must answer pre-determined open-ended questions and are thus used by many telecom specialists in their study. Semi-structured, in-depth interviews are commonly used as an interviewing format, either with a person or with a group**(Gender, 1998)** . ***Semi-structured interviews*** are conducted only once, with an individual or with a group, and generally cover a duration of around 30 minutes to more than an hour (**Diccico -Bloom B, 2006**). Semi-structured interviews are in-depth interviews in which respondents must answer pre-determined open-ended questions and are thus used by many telecom specialists in their study. Semi-structured, in-depth interviews are commonly used as an interviewing format, either with a person or with a group. **(Diccico -Bloom B, 2006)** . Interview guidelines are important for making the most use of interview time by investigating several respondents more thoroughly and methodically, as well as keeping the interview focused on the planned course of action.**(Diccico -Bloom B, 2006).**

For the telecom industry, several work groups are also working on different parameters attending those meetings also helps in sharing new techniques and providing new concepts. Research can be visualized and perceived as painstaking methodological efforts to examine, investigate as well as restructure the realities, theories, and applications. The strategy for solving the research problem is reflected in the research technique. Depending on the situation, the research technique might be a combination of qualitative and quantitative methods, or it could be qualitative or quantitative on its own. In this research work, we used a qualitative approach, in which a prospective researcher would fine-tune preconceived assumptions as well as extend the thinking process, examining and estimating the issues from a comprehensive standpoint. This might be accomplished through one-on-one interviews or issue-focused talks.



The above figure explains the semi-structured interview process where the interview is based on a document study (Problem study) where the interviewers know about the problem or try to optimize the process more efficiently. Having known the problem statement, we have analyzed the problem in more depth by attending more work group meetings within the organization at different platforms such as (GSMA, NGMN WG 2) all working to formalize the different categories within scope 3 emissions.

4.7.3 Analysis

In this section, we will explain the analysis part. As mentioned above about the data collection we have shown the process of data collection. We have received a product list from a supplier and from the KPN procurement team based on the list we have analyzed the key products based on quantity and weight for similar products. Based on the key product list we have contacted our suppliers for product life cycle reports, which gives detailed percentage of carbon footprint from cradle to grave.

For this research paper, we have conducted a few interviews with our key suppliers for discussions on key product lists and different types of LCA and analysis of different LCA.

4.8. Framework

This research paper is a case study at KPN in the context of scope 3 emissions. In general, there are 15 categories for scope 3 emissions and the organizations had to calculate all the emissions either by using spend based method or by using the average-based method. As we have described in the earlier chapter about the pros and cons of the organizational approach and about the availability of data which plays a vital role in evaluating scope 3 emissions. However, in this research paper, we have taken a different approach to optimizing the insights available from the ley suppliers in pursuing that we have conducted around 7 interviews with the key suppliers **(NOTE: Due to the privacy policy of KPN we have not mentioned the supplier's name. We will represent the suppliers with supplier A, B, C and likewise notation)**. We have also taken interview of two LCA scientists based out in Sweden and the United States of America, in the next chapter we will align the whole structure of methodology with the KPN objective and align our findings. We have also compared two different LCAs used by the majority of the telecom industry i.e., SimaPro and GaBi and we will discuss our findings.

4.9. Conclusion current state and qualitative analysis methodology

This chapter describes the current state analysis of products in the telecom industry. First, we have given a little background on KPN scope, the current state of emissions from energy, and the production phase as described in the first section of this chapter.

This chapter also describes the organizational approach and product-based approach and the important factors to optimize the product-based approach. We have also described the five steps of the product life cycle having a similar output as GHG protocol categories as mentioned in the section. Further in this chapter, we have also described the characteristics of the products depending upon the type of product their use, and based on that we have shown the emissions in different phases during the entire life cycle of a product.
In this chapter, we have also explained our methodology which is a qualitative research methodology based on semi-structured interviews with our key vendors attending different working group meetings working on scope 3 emissions, and the GSMA working committee working on formulating rules for categories of scope 3 emissions. We have described the framework for the next chapter where we are going to align all the parameters within KPN scope.

5

Results and Analysis

In the previous chapter, we discussed the steps in the product-based approach and organizational-based approach. We also discussed qualitative methodology, data analysis for scope 3 emissions, and about the semi-structured interview.
In this chapter, we are going to discuss and align the methodology with KPN's scope 3 objectives. We will also discuss KPN's carbon-neutral goal and the current methodology that KPN is using for calculating scope 3 emissions. We will also present the structure of our interviews which we have conducted with the different suppliers of KPN. This chapter also consists of a comparison of two different LCA i.e., the difference between GaBi and SimaPro and the factors which are important for the comparison and finally we will discuss the results. In this chapter, we will optimize the insights available from the suppliers in terms of products.

5.1 Goal of KPN

KPN is working constantly towards sustainability. KPN has already achieved the target for scope 2 and scope 1 emissions and trying to achieve the goal of carbon neutrality by 2040.

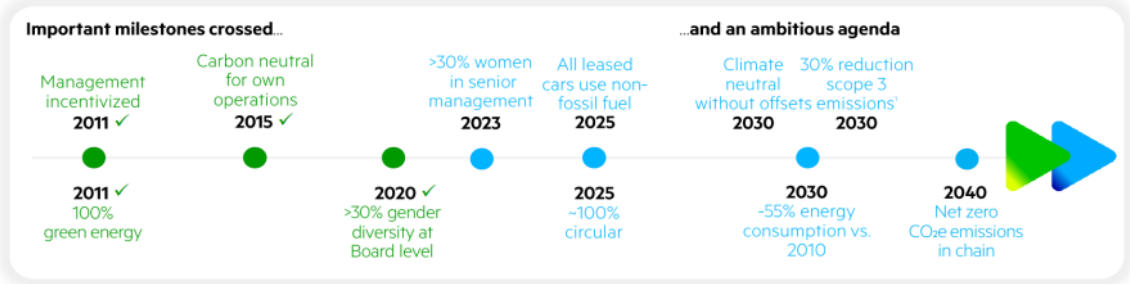


Figure 5.1 Goal of KPN (Source KPN annual report)

As we can see from the above diagram KPN has a goal to go net zero CO_2e emissions in chain

5.2. Collaboration towards a sustainable value chain

Over the past decades, KPN has established itself as one of the world's greenest telecom businesses, motivated by our conviction that sustainable business is better business. KPN upped their target this year to achieve net-zero carbon emissions by 2040. Suppliers and customer participation are critical across the value chain in order to build the solutions required to reach KPN's ambitious goal of being net zero by 2040.

KPI	Result 2021-22	Result 2020
% reduction in KPN Group energy consumption comapred to base y	45%	37%
ıction of value chain CO2 (Scope 3) comapred to base year	22%	19%
Prodcut with improved desing for circualrity	12	9
% resue and recycling	84%	81%

5.3. Collaborating towards zero waste and zero emissions

KPN's sustainability strategy is to affect the environmental effect of our whole supply chain, from suppliers to customers. KPN's primary objective is to achieve near-perfect circularity by 2025. KPN has established an objective of redesigning at least 15 typical KPN goods for circularity by 2022, for example, by utilizing recycled material. This covers network equipment as well as in-home devices like modems and set-top boxes. KPN's goal for outflow material is to maximize reuse and recycling while avoiding incineration and disposal. KPN is decreasing CO2e emissions from our business vehicle fleet by adopting zero-emission cars.

5.4 Optimization process

For optimizing insights available from the supplier that is product-based approach for different product. which mainly deals with optimizing the whole value chain process. We have conducted 7 interviews with the suppliers and 2 additional interviews with the LCA scientist. We have formulated different steps to optimize the insights available from the suppliers the steps are similar to "***Figure 3.5 on page no. 25 but more elaborated and defined"*** but are more described.

5.4.1 Document analysis

For this research paper we have analyzed different documents and LCA's report from different vendors. In the end of this file, we have added an extra file with excel sheet in APPENDIX 2 where we have describe about the key products from a list of 535 product provided by a supplier. we have shown the main product list consisting of 535 products, key product list and methodology used to

get the result. Going ahead we will show the analysis of LCA report and how it is beneficial to get the carbon foot print data from the report and how it is beneficial to know the products and compare those products with earlier product to meet sustainable goals.

5.4.2 Analysis of LCA's

Analysis for SAMSUNG Galaxy S22 (Life Cycle Assessment)

- ***For analysis of LCA report we have asked from KPN supplier to provide us with a LCA report they have provided us with SAMSUNG Galaxy S22 Phone.***

We will be provided with an example of a **SAMSUNG Galaxy S22**. This product LCA is provided by Samsung for academic purposes an LCA will provide us with important information such as GWP (Global warming potential) using that the parent company can switch products which are having less GWP.

In evaluating the environmental effects of its products across their entire life cycles, Samsung has gained considerable technological expertise. Potential environmental effects are evaluated for their product across the whole life cycle, including pre-manufacturing, product production, distribution, product manufacturing, distribution, product usage, and product disposal. The analytical process is finished following the global standard ISO 14040 series. Samsung used SimaPro 9.3.0.3, a version of the software with a dedicated LCA database, to measure the environmental impact using a variety of data for different categories, to obtain the highest level of accuracy. These categories include Product Bill of Material (BOM), Parts and Components Used, Logistics Data, Energy Consumption, and End-of-Life Data. These LCA reports are always taken in consideration to compare products from previous edition to check the eco-burden of the components used to manufacture product.

Calculation basis

Standard	ISO 14040:2006 and 14044:2006
Database	Eco invent 3.8v
Method of Impact assessment	Life cycle impact assessment classification and characterization factors according to CML2 baseline 2000 V2.05 / the Netherlands, 1997 as provided in the SimaPro 9.3.03 tool
LCA Software	SimaPro 9.3.0.3

Source: SASMUNG LCA Report 2022

The above table shows the ISO standard for the LCA tool with the Eco invent data-based version 3.8 used for the SimaPro LCA tool.

System boundary for LCA

Pre-manufacturing	Parts and materials constitution the products and their transportation
Manufacturing	Product assembly by Samsung Electronics
Distribution	From Korea to the Netherlands
USE	3 years use
Disposal	Waste treatment parts and materials

Source: SASMUNG LCA Report 2022

The second table explains the goal and boundary of the product. Which the operator needs to feed while performing the LCA of the above-mentioned product. Which includes distribution, duration of use, and disposal after end-of-life.

Product feature

Model name	SM09 – Samsung (galaxy S22)
Dimension	146.00*70.6*7.6mm
Display	OLED 6.1”
Weight	Product & acc – 189.17 g Packages – 116.91g

Source: SASMUNG LCA Report 2022

While performing an LCA it’s equally important to provide with product description which consists of the dimensions of the product (to know the size of the product), and the display size of the product as this is a phone. Finally, we need to provide the product weight with and without accessories to assume the GWP(Global warming potential) based on weight.

GWP of the components

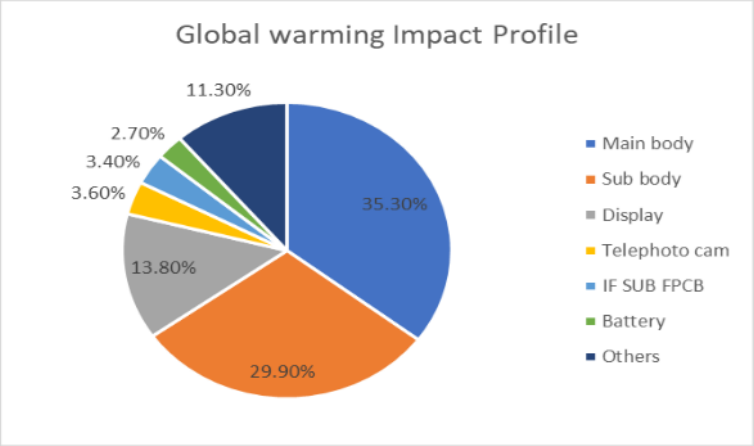


Figure 5.7: Global warming impact profile (Pi-chart for GWP)

As we have provided different data above related to product description, goal, and scope. After performing an LCA assessment of the above mention product we have found the GWP of the total components used to manufacture that phone. Based on the analysis of the Product life cycle of the product we have found that the main body of the product, sub-body, and display is most environmentally hazardous as compared to the rest of the parts. We can conclude that with more sustainable and recyclable products we can reduce the GWP of the parts through new product design.

Life cycle assessment result (Global warming potential)

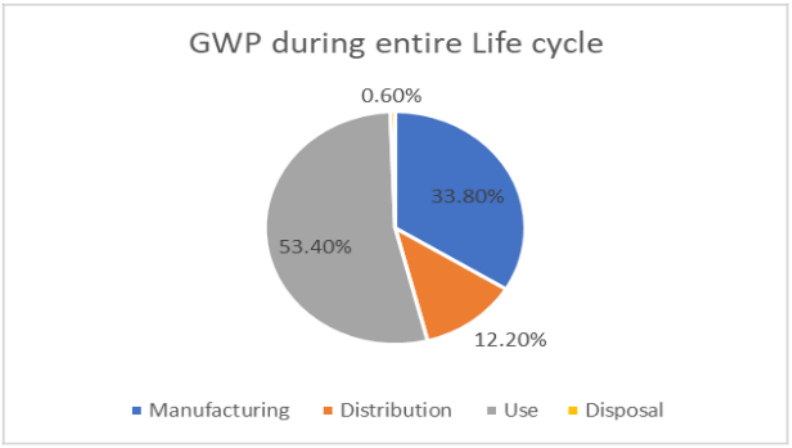


Figure 5.8: Global warming potential during the entire Life cycle

As we can see from the figure an LCA result will provide you with several results corresponding to their global warming potential. Analyzing these results, a company analyzes the carbon footprint from category 4 which is purchased goods and products. However, LCA results are the best way to know how environment-friendly products are based on carbon footprint emissions one can take a decision for the purchase of the product and also know how products are behaving to the environment.

5.4.3 Interviews Process (Semi-structure interviews)

For this research and to optimize the insights available from the vendors we have taken two major steps firstly, we have analyzed different documents from (KPN data base) to know the key vendors, key products. Secondly, we have taken couple of interviews of key suppliers to know there prospective on the steps important to optimize the product-based approach.

First Part (Step 01) Similar to figure 3.5 given on page no:25 (More detailed)

The very first part shows to the identification of the hardware vendors from which KPN purchases goods and services.

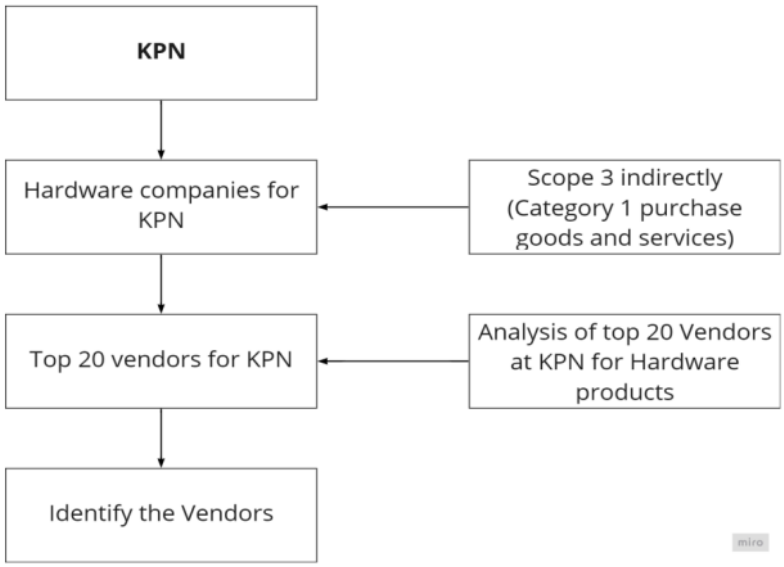


Figure 5.2: First step towards optimization

The second part (Step 02) similar to figure 3.5 given on page no.25 (More detailed)

The second part shows to the identification of the products within the organization based on quantity, Weight, and Price.

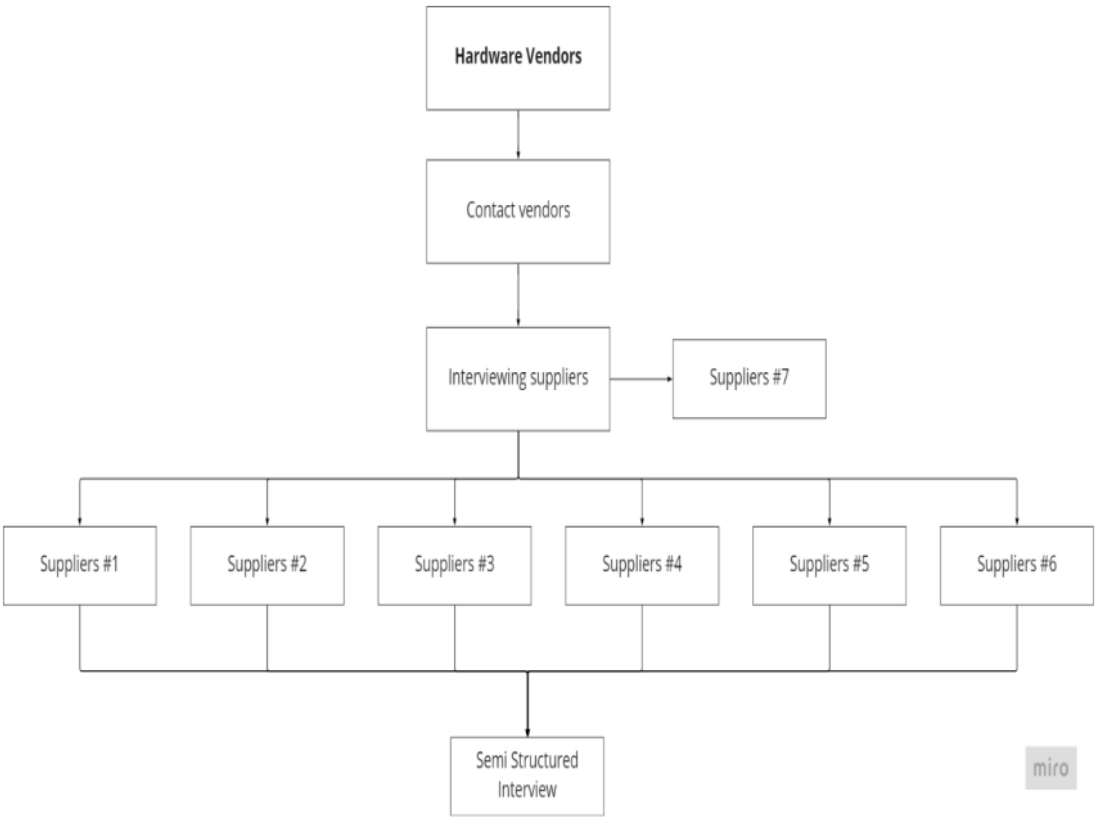


Figure 5.3: Second step towards optimization

The third part (Step 03) (More detailed)

In the third part, we need to know the products procured by the KPN for a year (For the year in the calculation for scope 3 emissions). The products should be hardware products such as a router, mobile devices, and network antennae likewise. We need to prepare a list of products to procure for that particular year, the list can be provided by the product owner of the supplier organization or the procuring team of the parent organization who is calculating emissions for scope 3.

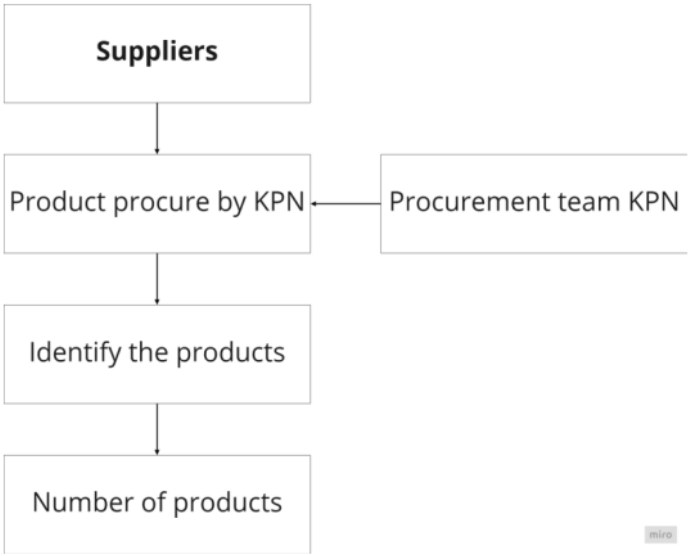


Figure 5.4 Step 03 for optimization

The fourth part (Step 04) (More detailed)

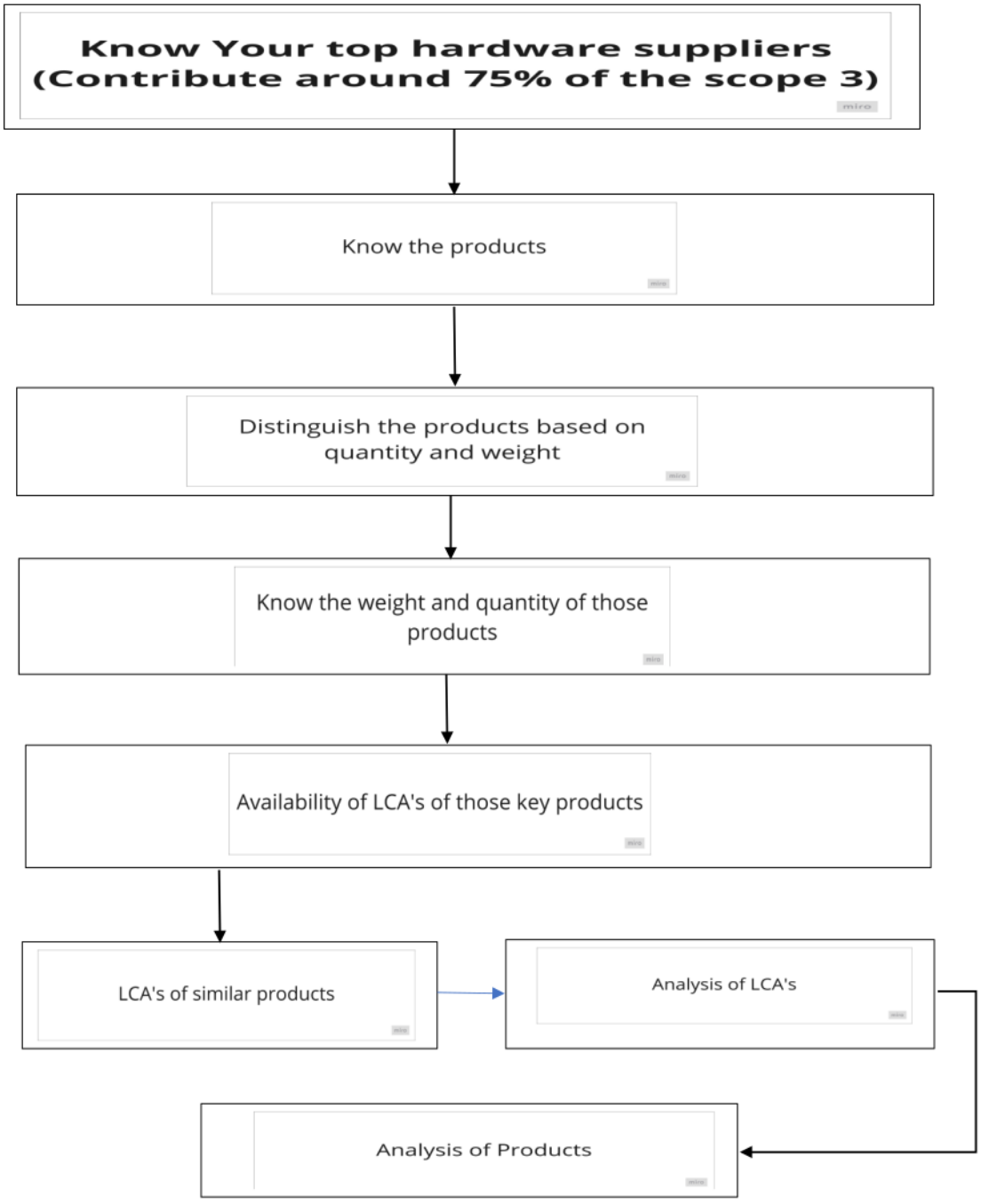
Once we received the product from the suppliers if the product contains more than 30 products procure by the organization in that case, we need to distinguish the products based on Weight, Quantity, and price.

The fifth part (Step 05)

Based on the above analysis and procedure we can formulate that if the number of products procured by the organization is on the higher side (>30), in that case, we should bring it down to the key products. As those products are more environmentally hazardous based on weight as they consist of more components hence more carbon footprint in manufacturing those components. Based on that analysis we will ask for LCA's of those products from our suppliers from which we will be able to fetch the carbon footprint from ***cradle to grave*** of those products. We would be able to understand the component and total carbon footprint generated during the entire life cycle and LCA's also provide information on the recyclability of those products (% of component) that can be recycled.

Final Result

We have elaborated the figure 3.5 on page 25 in this chapter. Figure 5.2,5.3 and 5.4 shows the expanded view and describe steps of the figure 3.5 in a more sub steps.



5.5. Comparison of Two different LCA's

In this research paper, we have compared two different LCA i.e., SimaPro and GaBi used by the majority of the organization to know about their products. Our result of differences is based on an interview with two different LCA scientists who work for Huawei and Nokia.

1. Mr. Anders Andrae (LCA Scientist, Huawei, Sweden)
2. Mr. Tom Okrasinki (LCA Scientist, Nokia, USA Seattle)

Our result is also based on a theoretical analysis of two different LCAs.

SimaPro and GaBi*)* are the two most popular LCA software tools, and both are widely utilized around the globe. Does it matter which software we pick if we intend to use this sort of sophisticated software to aid in carrying out a quantitative environmental LCA? The objective is to provide the best comparison.
Software for product system modeling and evaluation, known as GaBi, was created and distributed globally by the German firm PE INTERNATIONAL in 1992. SimaPro is a product system modeling and evaluation program that was introduced in 1990 and is also available internationally; it was created and distributed by PRé Consultants, a Dutch company ***(Anneke, Pre-sustainability 2012).***

Both software programs come with.
a. A user interface for the product system modeling
b. A database for life cycle unit processes
c. A database for impact assessments that contains information to assist various life cycle impact assessment techniques.
d. A calculator that aggregates data from databases in line with the user interface's modeling of the product system.

These software's advantages and disadvantages are listed below:

SimaPro

Pros

SimaPro is a life cycle assessment software tool that is widely used and has undergone extensive testing. SimaPro's popularity also makes it simple to share its results and reports with others. The program's hardware and software requirements are also not too onerous.

Cons

You need Windows to utilize this life cycle assessment program. There is no support for any operating system other than Windows, and stability may be a problem if SimaPro is used through an emulator on any other native operating system. Every device running SimaPro on a server also

needs 5 GB of hard disk space. It is highly advised to use a wide monitor for high-resolution modeling.

Significant Qualities

Numerous different items and systems may have their carbon footprints determined using the SimaPro life cycle analysis program. SimaPro can even accurately predict the possible environmental impact that a system or service could have using its programmable parameters and Monte Carlo analytical capabilities. SimaPro provides a comprehensive perspective of the possible effects that any design will have under actual circumstances thanks to its ability to identify key performance indicators and produce complete Environmental Product Declarations and GRI Environmental Reports.

GaBi

Pros

GaBi's life cycle assessment software solutions are assured to be able to meet your demands because they provide a complete software package, including iReport. GaBi can also help you create goods with more ecologically friendly features including fewer greenhouse gas emissions, less water usage, and less waste. GaBi is also fantastic at assisting a business in maintaining compliance with environmental rules and building value chains from R&D through design, production, procurement, and distribution networks. This life cycle evaluation software also enables internal reporting and analysis sharing throughout the many divisions of your business.

Cons

The tools included in the GaBi life cycle assessment software, such as iReport, frequently need to be downloaded and updated separately from the main application. The program, which seems to still be using its original codebase and is more than a decade old, is fairly awkward and has a steep learning curve. Many of the included dataset's background documents are sparse and opaque, necessitating reliance on their support personnel.

Significant Qualities

You may sketch out your ideas on the GaBi interface. Choosing the proper dataset for the type of data documentation you need is made simpler by GaBi, and you can utilize its inbuilt database documentation to help with the design. You may gather information from every stage of the design process and pinpoint exactly where efficiencies occur with GaBi's process recording capability. The International Life Cycle Database formatting is used by GaBi to publish its database documentation.

5.6. Conclusion

In this chapter we have shown the step wise optimization process for supplier engagement for the insights available. We have also shown SASMUNG product LCA analysis and what kind of data is available from an LCA report that is the product based LCA report for key products. In LCA report with the help of pie chart we have shown GWP of the major components of the product and also global warming potential that is carbon footprint during entire life cycle. To know the differences between two LCA's tool we have taken interviews of two LCA scientist to fetch LCA report we mainly use two types of LCA tool i.e., SimaPro and GaBi in this chapter we have also shown the main difference between the two types of LCA in terms of accessibility and database. In the end of the section, we have given final flow chart to optimize the insights available from the suppliers for product-based approach. However, the flowchart shows all the important aspect to optimize the insights available from the supplier in few cases the supplier will not be able to provide us with the data as the product could be really small for example : Sim card , in such cases we have assume the eco-burden of the product by assuming the years it has been used i.e., emissions during use phase.

6

Conclusion

This chapter represents the conclusion of this research paper, recommendations, and the discussion. In section 6.1 we will answer the main research question of this research paper this is done by providing the conclusion of different sub-research questions. In section 6.2 we will provide the recommendations for scientific research and the recommendations for implementing this research at KPN TO Energy and Environment. Finally, in section 6.3 we will provide the limitations of this research.

6.1. Conclusion

This part will provide a response to the primary research question.

How can we optimize the insights received from the suppliers/vendors to lower supply chain emissions towards net zero scopes 3 in the supply chain?

This major research issue may be answered by stating the sub-aspects of the question as follows:

- First, the definition of scope 3 emissions needs to be made clear.
- Second, need to know the categories of scope 3 emissions directly responsible for emissions such as category 4 and category 1 related to products.
- Third, need to know the products which we receive from different suppliers.
- Fourth, based on the product list need to know the key products.
- Next, analysis of products based on LCA's of those products.
- Finally, Comparison of LCA's.

As we have discussed all the sub-research questions in the previous chapters, we will answer the main research question. Based on the sub-research questions we have found that to optimize the insights available from the suppliers we need to know a few steps:

- Know your key suppliers
- Products purchased from these suppliers

- Verify the product list within your organization
- Know the key products based on weight and quantity
- If the LCA is not available for those products look or similar products
- Analyze those LCA's, carbon footprint, recyclable components
- Know the LCA tool used
- Compare those LCA's

The answer to this research question is given by answering the different sub-research questions above where we have answered a different sub-research question related to the main research question. We have shown the flow chart and the important factors to consider for the optimization. Well, to optimize the product-based approach we have concluded to go for a product that KPN receives from different hardware (B2B, B2C, and Network) suppliers. In doing so there would be a bit of a dilemma of LCA's or it wouldn't be available with the supplier, in that case, we can consider the LCA's of a similar product and we should analyze the LCA's for scope 3 emissions. There are different LCAs available in the market such as GaBi and SimaPro we need to make a comparison of two LCAs and should recommend them based on pros and cons. To conclude the research, we have shown that to optimize the product-based approach and for the calculations made for scope 3 emissions we need to

6.2. Limitations

There are a few limitations to this research. First, the data which is sued for this research was not completely available the main data source which is used for this research consists of hand-scanned documents asked from a few suppliers.

The data in the stream consists of a hand-measured value for scope 3 emissions they have three factors of uncertainty. Uncertainty because of relevancy of data, uncertainty because of the used version of the database in LCA's tool, and finally uncertainty of LCA report.

Even though there is a lot of uncertainty related to the availability of data, the analysis part and interview give a realistic reflection of reality. Most of the time the suppliers are not aware of LCA's, or they don't want to reveal their LCA's tool used to know the product life cycle report generation. Even there is uncertainty on the LCA report as the data based used might be of old version providing false reports. In such cases, we will not be able to compare our products from past years products to see the sustainability of the products and the circularity of those products.

6.2.1. Recommendation to KPN TO Energy and Environment

As stated in this research we need to follow a few steps mentioned in the previous chapter related to optimizing the insights available from the suppliers. The first and most important task is to have a product list. Once we have the product list start contacting suppliers to verify the list. Based on the key product list we should have LCA's of those products if not then we should have LCA's of similar product categories. Analyze that LCA which tells us about the carbon footprint during the

entire life cycle process we would also come to know about the products which can be recycled and used again by doing KPN will be knowing about the products they are receiving as KPN needs to meet 100% circularity for 2040. To calculate the emissions for category1, 4, and 6 which tell us about purchased goods and services, upstream emissions, and downstream emissions we would recommend taking both approaches i.e., both organizational and product-based approaches.

This part discussed the suggestions for continuing the scientific research, as well as recommendations for more research and advice for maximizing the insights of this research at KPN TO Energy and Environment.

6.3. Recommendations for future research

With the outcome of this research paper, a path is opened for further research into the calculation of scope 3 emissions. Multiple research questions arise from the conclusions of this research.

Firstly, in the calculation of scope 3 emissions as we know from the previous chapter there are 15 categories on which scope 3 is divided. Which consists of different categories from upstream calculations to downstream calculations. This research paper focuses on a product-based approach for categories 1, 4, and downstream emissions. Firstly, a study is to be conducted on the calculations of different scopes of emissions which will help other vendors to calculate their scopes. The next recommendation is to verify the Eco invent database which is used by different LCAs for performing the exercises its equally important to know that which will help the manufacturers to know about their products.

Finally, concrete recommendations for achieving this framework and securing research in this area are provided to continue to conduct three other cases at KPN TO Energy and Environment. The first on the other ASSY's, with emphasis on sustainable product design for the vendors. The second one is to know the circularity of the products within KPN (% of products recycled and recommend to the manufacturer about the output) this way KPN will be able to achieve 100% circularity by 2040 and net zero carbon footprint by 2040.

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Appendix 1

1. *Interview Questions asked during interviews of suppliers.*

a. Product-related questions

- What departments/roles are involved in the process of the product supply to KPN?
    - What are all the processes involved in transporting a product from a manufacturing site to KPN
    - Who is responsible for the product sold out to KPN?
    - Who is responsible for the environment and sustainability-related goals for your organization?
- For which market are you responsible for- (B2B, B2C, or Network)?
- Can you provide us weight & quantity of key products?
- Do you have a product passport for any of those products?
- Do you recognize this list of key products is supplied to KPN? (Based on query via CPO)

b. LCAs and environment-related questions

- What method do you apply to get the LCA of those products?
    - How can KPN best compare solutions in the same domain?
    - What standards to build LCA do you find most relevant?
    - How does this standard compare to other standards?
- Do you have a product passport with additional measures other than quick LCA for those key products (e.g.: repairability etc)?
- What is your view on EPD and how is your company introducing this?

Appendix 2

Data provided by various suppliers of KPN in excel sheet the data contains as follows:

- *Products procure by the suppliers in B2B, B2C, and Network.*
- *Products quantity for last year till Q1 March (2022)*
- *If possible, Weight*

We are providing a short picture of excel consisting of products in number 535, which we have further brought down to 30 products.

Supplier A key products from 2021-22(Until march)

- To fetch key products from a list of products.

Objective: To fetch the list of key products based on the list received from supplier A

Methodology: Analysis based on (Quantity and Weight).

Description.

In terms of key products from supplier A, we have selected the products based on quantity and weight.

MNM product consists of 98.7% of total weight which can receive from Huawei in 2021-22 (Until march) as ETN-IP and OTN consist of only 0.5% and 0.8% of the total weight we are not considering that product in terms of environmental impact as their weights are less in comparison to **MNM** products.

Items Received = 1,505,892

Products	Quantity	Weight	Percentage (%)	` Contribution
MNM	1,470,336	1,701,069	98.7%	Majority
ETN-IP	27,361	8,671	0.5%	Minimum
OTN	8,195	13,118	0.8%	Minimum

Total	1,505,892	1,722,857	100%	

For this analysis, we are not considering the product whose weight is less close to zero or in the round off to 1kg as we have assumed that that product will have a minimum environmental impact for more realistic research, we have considered all the products of the weight of around 1kg for MNM, ETN-IP, and OTN. ‘

As you can see from the table, we have not considered the products listed under ETN-IP and OTN as they contribute minimum weight i.e., 0.5% and 0.8%, Hence for the calculation and to know the contribution for Scope 3 we will not consider ETN-IP and OTN products.

			Amounts				Weight (Kg)			Weight (%)			
BOM Code	Description	Unit Weig	MNM	ETN-IP	OTN	Total	MNM	ETN-IP	Total	MNM	ETN-IP	OTN	Total
01074779	System Power,MTS9304A-HD16KP-4779,220/380Vac Th	150	1778	0	0	1778	266700	0	266700	15.7%	0.0%	0.0%	15.5%
02312GEB	RRU5509t,WD5MYAAJICI,WUYI,TX758-788MHz/RX703-7	25	5176	0	0	5176	129400	0	129400	7.6%	0.0%	0.0%	7.5%
02312BSJ	RRU5502,WD5MZAAPIAAD,WUYI,TX1805-1880MHz/RX1	25	5121	0	0	5121	128025	0	128025	7.5%	0.0%	0.0%	7.4%
27013448-001	Directional Antenna,D11X-2x(690-960)/1427-2690/2x(169	50	2117	0	0	2117	105850	0	105850	6.2%	0.0%	0.0%	6.1%
27013448	Directional Antenna,D11X-2x(690-960)/1427-2690/2x(169	56.5	1862	0	0	1862	105203	0	105203	6.2%	0.0%	0.0%	6.1%
02312GUW	RRU5301,WD5MLRUMGY0,WUYI,TX1452-1492MHz -48\	15	5548	0	0	5548	83220	0	83220	4.9%	0.0%	0.0%	4.8%
01074746	Lithium Battery,ESM-48100B1,442mm (W)*396mm(D)*130	45	1848	0	0	1848	83160	0	83160	4.9%	0.0%	0.0%	4.8%
01074746-008	Lithium Battery,ESM-48100B1,442mm (W)*396mm(D)*130	43	1600	0	0	1600	68800	0	68800	4.0%	0.0%	0.0%	4.0%
02312QFS	RRU5258,WD5MPRU8I9C2,WUYI (TX:2575-2615MHz/RX	26	2234	0	0	2234	58084	0	58084	3.4%	0.0%	0.0%	3.4%
02312LXR	RF Module,RRU5301,WD5MLRUMG7L,WUYI,TX2650-26	15	3046	0	0	3046	45690	0	45690	2.7%	0.0%	0.0%	2.7%
02233CBJ	Subassembly I Accessories,Huawei Antenna & RET, AISU	4.75	5604	0	0	5604	26619	0	26619	1.6%	0.0%	0.0%	1.5%
02312JVU	AAU5973e,WD7METPE3300,1800A(TX1805~1880/RX171	75	250	0	0	250	18750	0	18750	1.1%	0.0%	0.0%	1.1%
27013111-002	Directional Antenna,D8X-2x(690-960)/1427-2690/2x(1695-	43	420	0	0	420	18060	0	18060	1.1%	0.0%	0.0%	1.0%
02370370	Combined Spart,01060523,02230DYB,5G BBU module wi	10.1102	1721	0	0	1721	17399.6542	0	17399.6542	1.0%	0.0%	0.0%	1.0%
14130645	Optical Cable Parts,DLC/UPC,DLC/UPC,single mode,50m	2.13	8168	0	0	8168	17397.84	0	17397.84	1.0%	0.0%	0.0%	1.0%
21155211	Engineering Installation Kit,DKBA40722214.ASM,Base,Sh	22	789	0	0	789	17358	0	17358	1.0%	0.0%	0.0%	1.0%

Figure: 01 (List of Key Products)

Key Product Description:

Unit Weight:

Unit Weig
150
25
25
50
56.5
15
45
43
26
15
4.75
75
43
10.1102
2.13
22

Quantity

MNM
1778
5176
5121
2117
1862
5548
1848
1600
2234
3046
5604
250
420
1721
8168
789

Total

Total
1778
5176
5121
2117
1862
5548
1848
1600
2234
3046
5604
250
420
1721
8168
789

MNM Total:

MNM
266700
129400
128025
105850
105203
83220
83160
68800
58084
45690
26619
18750
18060
17399.6542
17397.84
17358

Total

Total
266700
129400
128025
105850
105203
83220
83160
68800
58084
45690
26619
18750
18060
17399.6542
17397.84
17358

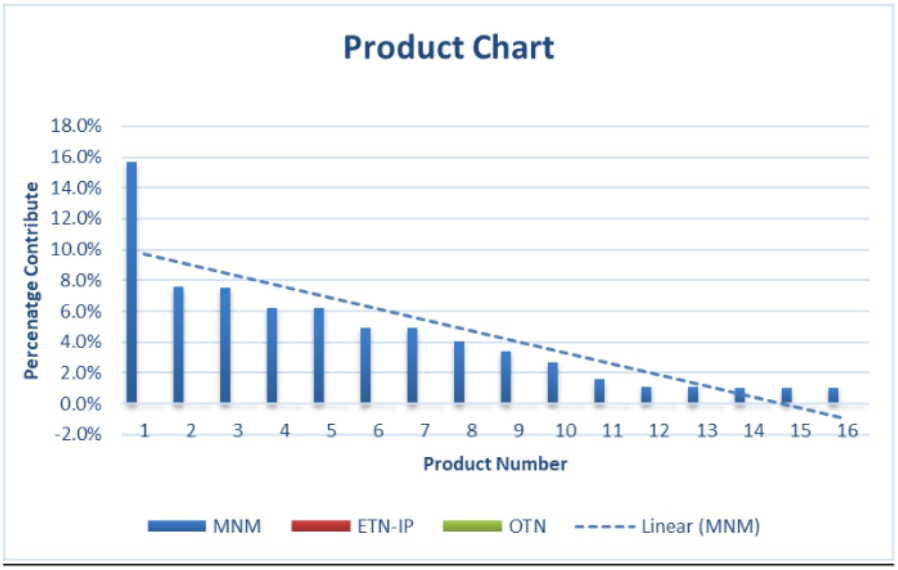
Weight Percentage

MNM
15.7%
7.6%
7.5%
6.2%
6.2%
4.9%
4.9%
4.0%
3.4%
2.7%
1.6%
1.1%
1.1%
1.0%
1.0%
1.0%

Weight Percentage:

Weight (%)			
MNM	ETN-IP	OTN	Total
15.7%	0.0%	0.0%	15.5%
7.6%	0.0%	0.0%	7.5%
7.5%	0.0%	0.0%	7.4%
6.2%	0.0%	0.0%	6.1%
6.2%	0.0%	0.0%	6.1%
4.9%	0.0%	0.0%	4.8%
4.9%	0.0%	0.0%	4.8%
4.0%	0.0%	0.0%	4.0%
3.4%	0.0%	0.0%	3.4%
2.7%	0.0%	0.0%	2.7%
1.6%	0.0%	0.0%	1.5%
1.1%	0.0%	0.0%	1.1%
1.1%	0.0%	0.0%	1.0%
1.0%	0.0%	0.0%	1.0%
1.0%	0.0%	0.0%	1.0%
1.0%	0.0%	0.0%	1.0%

Graphical Representation of products:



Number #1 Product having higher contribution and likewise for MNM.

MNM: Mobile network (Radio access network)

ETN-IP: Ethernet – IP network

OTN: Optical transport network (KPN wavelength division)

Result:

Based on the product received from Huawei for the year (2021-22) March. We have found that MNM contains the majority of products with a weight of more than 1kg and quantity. We have considered all those products of weight more than 1 kg and the products, which have contributed to 100% of total weight and we have found that MNM contributes the majority as compared to ETN-IP and OTN.