Sustainable IT Procurement

A case of Network and Telecommunications (N&T) Services Sourcing

Master's thesis in Supply Chain Management

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Abstract

Volvo Group, being an industry leader in sustainability, has developed a sustainability strategy that considers the climate, resources and people. The targets set within their sustainability strategy follow the Paris agreement requirements and UN sustainability development goals. Further, Volvo Group aims to generate 50% of their revenue through providing sustainable transportation as a service, for which IT purchasing is critical. Thus, Volvo Group believes it is necessary to investigate their present sustainable IT procurement strategies and to develop them. This study considers Network and Telecommunications (N&T) services as an initial step towards sustainable IT procurement.

The objective of the thesis is to develop sustainable procurement strategies in sourcing N&T services. To achieve this objective, critical sustainability risks within the N&T industry and their mitigation are investigated, based on which recommendations are suggested to the case company. Internal interviews with case company employees and external interviews with three N&T service suppliers were conducted to achieve the objective. The suppliers interviewed in the study are part of the case company's supply base. The internal interviews helped the authors in understanding the current sustainable N&T services sourcing strategies, whereas the external interviews facilitated an understanding of the N&T industry sustainability risks and the mitigation approaches pursued by the suppliers. In addition to the interviews, internal documents and annual sustainability reports of the interviewed suppliers were reviewed.

A review of the present sustainability strategies in sourcing of N&T services showed that these strategies assess only the risks that are associated with automotive purchasing. Further, the study identified critical sustainability risks associated with the operations of telecommunication operators (TCO) and their supply chains. The main sustainability risks posed by a TCO´s operations are energy consumption and large amounts of electrical and electronic waste. The literature review highlighted the importance of assessing the sustainability risks within the supply chain of the suppliers, especially when sourcing services. In this regard, a TCO´s supply chain poses sustainability risks related to human rights, and potential use of hazardous materials and conflict minerals within the products sourced.

Since the current strategies of responsible sourcing at the case company are not addressing the specific risks of the N&T industry, a questionnaire addressing these specific sustainability risks is devised by the authors. The sustainability questionnaire can play a critical role in future sustainable sourcing decisions.

Keywords: Sustainable Sourcing, Sustainability Risks, Risk Mitigation, Network and Telecommunications (N&T), Telecommunications Sustainability Questionnaire, IT Purchasing, Telecommunication Operators (TCOs)

Acknowledgment

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Firstly, we would like to extend our gratitude to our supervisors at Volvo Group, Ludovic Marcel and Guillaume Toutut and all the other colleagues who helped and guided us throughout the study. It was a pleasure to work with the digital & IT purchasing department at Volvo Group and we believe that we would not have achieved these results without the feedback and guidance from all involved.

We would also like to express our gratitude towards the suppliers of Volvo Group who contributed to this study by providing us guidance and assistance throughout the thesis.

We would also like to thank our supervisor and examiner, Anna Dubois, at the Chalmers University of Technology who constantly guided us throughout this study. Your feedback and guidance helped us in completing this study smoothly on time. Also, we would like to thank all the suppliers for their collaboration in the study, without which the study results could not have been achieved.

Chaitali Patil and Srisha Karnam,

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1 Introduction

The increasing globalization and global warming have put immense pressure on focal companies to reduce their carbon footprint and risks on society. To manage global warming and limit it to 1.5 C, it is both a challenge and an opportunity for the organizations to reduce the emissions associated with the products and services procured (scope 3 emissions). Apart from the environmental impacts in the supply chain, there are other social sustainability risks associated with human health and safety that need to be addressed. As a result of all these requirements, a novel way of managing the supply chain has emerged and is referred to as "Sustainable Supply Chain Management (SSCM)". The objective of SSCM is to ensure a minimum performance by the suppliers on the three levels of sustainability (economic, environmental, and social). This study revolves around assessing the environmental and social sustainability risks within the network and telecommunications (N&T) industry and how the case company could take actions for responsible sourcing of N&T services. The operations of the telecommunication service providers have significant impact on various sustainability risks which need to be evaluated. Further, it would not be enough to investigate the operations of the service providers, it is necessary to assess the risks in multiple tiers of the upstream supply chain as well.

This chapter will present the content of this report starting with the background, followed by the aim of the study and research questions. At the end of this chapter, an outline of the report will be presented.

1.1 Background

Volvo Group is at the industry forefront in the drive towards a sustainable future. "In all our actions, we need to consider how to reduce climate impact, use the world's resources and conduct business more responsibly." (Volvo Group, 2021b) Volvo Group believes that corporate responsibility and sustainability are the important aspects for their success. Volvo Group is determined towards fulfilling its commitments to the goals of the Paris agreement and leading the industry in the transformation towards net-zero greenhouse gas emissions. The ambitions and targets are set in line with the latest climate science to limit global warming to 1.5°C degrees and the targets and methodology have been approved by the Science Based Targets initiative (SBTi) (Volvo Group, 2021b).

> Reaching the targets will require joint forces throughout the organization and close cooperation with our customers, suppliers and partners as well as societal developments to enable this development. There are many factors beyond our control, but with broad and ambitious collaborations, we will work hard to meet the ambitions set (Volvo Group, 2021b)

Further, "The Sustainability ambitions of the Volvo Group to create sustainable supply chain are focused on Climate - Resources - People" (Volvo Group, 2021a).

Volvo Group has the vision of being the most desired and successful transport and infrastructure solution provider in the world and with this as the vision, Volvo Group is revolutionizing its business model towards a servitized business model. This servitization and the increase in digitalization has

expected to increase Volvo Group´s purchasing spend on sourcing of indirect products and services (IPS) that support the development of digital technologies which has become the key for value creation in the service-based business model (Volvo Group, 2022).

Volvo Group aims towards being an "all round perfectionist", an organization that considers greater number of sustainability criteria in most of its sourcing projects and these sustainability criteria are based on all the three dimensions of sustainability (environment, economic and social) as identified by Schneider and Wallenburg (2012). Further, Haake and Seuring (2009) argues that it is important for organizations to consider sustainable sourcing even in the case of procurement of minor items and non-product related purchases (indirect procurement) to be truly sustainable. Although, they (indirect products) could be regarded as minor items at the firm level but they have significant impacts when summed up over the economy.

In this context and with its ambition towards a sustainable future, Volvo Group finds it necessary to investigate sustainability across its supply network within the sourcing of N&T services as a beginning towards sustainable IT procurement.

1.2 Aim of Study

The study aims to propose recommendations on how the case company can develop their sustainable procurement strategies to address the specific sustainability risks identified in the Network and Telecommunications (N&T) services. To achieve this, the authors identify the specific sustainability risks in the operations and the supply chain of the N&T industry. Further, the case company´s current approaches and the sustainability strategies of other customers similar to the case company are studied and based on this, certain strategic recommendations are proposed. The deliverables for this thesis include but are not limited to:

1) A summary of the sustainability risks that are present in the operations and the supply chain of the telecommunications operators (TCOs) and the strategies undertaken by them to mitigate these risks.
2) Review of the case company´s current approach towards sustainable procurement and a summary on how other customers similar to the case company work with the TCOs towards sustainable development.
3) Recommendations to the case company on how it can develop its sustainable procurement strategies.

By achieving the set objectives of this thesis, it is believed that the case company addresses the specific sustainability risks observed within the N&T industry when sourcing N&T services.

1.3 Research Questions

In order to fulfil the aim of this study and to ensure responsible sourcing of N&T services at the case company, it is important to understand the network and telecommunications industry and its sustainability risks to evaluate the suppliers and promote sustainable supply chain management.

As a first step, it is important to identify the sustainability risks within the network and telecommunication industry and its mitigation. Understanding the mitigation of the sustainability risks is critical for the case company in-order to follow-up the progress of the suppliers with respect to sustainability performance. Therefore, the first and the second research questions are formulated as,

RQ1. What are the potential supply chain sustainability risks in sourcing of N&T services?

RQ2. How can the supply chain sustainability risks that have been identified in the RQ1 be handled to increase performance?

Secondly, once the sustainability risks within the network and telecommunications industry have been studied, it is important to investigate how the case company can make use of the findings from research questions 1 and 2 for sustainable sourcing. Therefore, the second research question is formulated in a way to explore the best approach towards the right supplier selection based on the targets and current way of working of the case company. The third research question is formulated as,

RQ3. Based on the findings from RQ1 and RQ2, how can Volvo Group assess the sustainability performance of the suppliers while procuring N&T services?

Once an approach for selecting the right supplier is decided, it is equally important to investigate a method by which the supplier´s performance can be continuously tracked and monitored during the whole contract life cycle period. Therefore, the fourth research question is formulated as follows,

RQ4. How could the findings from RQ3 be used in the case company´s governance model to follow-up?

Lastly, the telecommunication service providers have a plethora of business customers from different industry sectors. Thus, it is beneficial to the case company to investigate how other customers of N&T service providers engage in sustainable development, which will ultimately help in adapting to the best practices. Therefore, the final research question is formulated as,

RQ5. How can Volvo Group adapt based on how other customers engage in sustainability initiatives with the N&T service providers?

1.4 Limitations

As the network and telecom sector is too broad to address, the focus of this thesis is to address the fixed telephony and mobile telephony services within the sector. The suppliers of fixed telephony and mobile telephony have a large customer base, this thesis focuses only on Volvo Group and its interaction with mobile and fixed telephony service providers. The interviews conducted in the study were only with tier 1 suppliers and were not extended to their supply chain. Also, within these supplier interviews, the interviewees were from the sustainability function and lacked detailed technical knowledge. Interviews

with technical people such as the network engineers from the supplier companies would have yielded a different result. The data collection was limited to the suppliers located in the developed countries. The authors believe that the interaction with suppliers from developing countries might have different results as the risks that are observed by these suppliers may be different. Also, the data collection was limited to interviews and no physical visits to the operational sites were made.

1.5 Structure

The report comprises of the following sections: introduction, analytical framework, method, network and telecommunications services, Volvo Group's sustainable sourcing approaches, findings and results, discussion, conclusion, and recommendations. The contents of the report are noted in Table 1.1.

Table 1-1 The structure and content of the report

Chapter	**Description**
Introduction	This section discusses the background of the case company, the aim and research questions of the study and the limitations for the research
Analytical Framework	This section discusses the framework for the research and acknowledges topics such as procurement and sustainability
Method	This section explains the way the research is conducted
Network and Telecommunications	This section describes the N&T operations and its supply chain. Also, the sustainability risks within the N&T industry and their mitigation are identified.
Volvo Group's Responsible Purchasing	This section acknowledges the case company's current approach on sustainability
Findings and Results	The data collected is presented in this section
Discussion	Each research question is discussed with respect to the findings and supported with literature review

Conclusion and Recommendations	The conclusion of the study followed by the recommendation for the case company are presented. Also, future research work is acknowledged to further improve the study.

2 Analytical Framework

The study focuses on sustainable sourcing of N&T services. This section describes the broader theoretical concepts on the study topic. Firstly, various aspects around purchasing are introduced, followed by several aspects around sustainable supply chain management.

2.1 Purchasing

The value chain is a set of activities which helps an organization to deliver an offering as a value in terms of products or services. Purchasing is one of the most important propositions of a value chain and it is defined as, the management of an organizations primary and support activities by the external resources like the goods, services, knowledge, and capabilities to run, maintain and manage the organization. These activities should be secured in the most assertive and favorable way to fulfill the materials, information, and money flow to the point of consumption. (Van Weele, 2018). Primary activities are those which are delivered to the customers as an organization's major value-based offering such as automobiles, trucks, construction equipment etc. Whereas the activities which enable and support the primary offering of an organization are known as support activities or secondary activities such as contracting laborers for cleaning for an automotive company (Van Weele, 2018). The direct purchases come under primary activities while the indirect products are classified as indirect products. Purchasing has a strategic role for an organization due to the transaction cost of economics theory and the benefits associated with it like economies of scale, purchasing externally etc. (Van Weele, 2018).

The intangible resources that add value in forms such as convenience, comfort, health, amusement etc. and are consumed at the very moment it is produced such that an organization pays for it, are termed as services (Quinn et al., 1987). In contrast to this, goods are the tangible resources having an exchangeable value with ownerships rights which can be established and exchanged (Parry et al., 2011).

2.2 Supplier Selection

"One of the critical challenges faced by purchasing managers is the selection of strategic partners that will furnish them with the necessary products, components, and materials in a timely and effective manner to help maintain a competitive advantage" (Sarkis & Talluri, 2002). According to Kannan and Tan (2002), the increase in the outsourcing of non-core activities in-order to focus and invest resources on the core competencies has led to significant reliance on suppliers and thus, effective supplier selection and assessment has become very important than ever. This view on the increasing importance of the procurement function is further supported by Beil (2010) by stating that the increasing purchasing spend and reliance on outsourcing of complex products and services has led to procurement function not only becoming important but challenging as well.

The linear purchasing process model and the extended purchasing model proposed by Van Weele (2018) identifies supplier selection as one of the key activities of the purchasing process. The extended purchasing model proposed comprises of three distinct key processes, namely, Source, Purchase and Pay and supplier selection is a part of the sourcing process. Supplier selection process can be defined

as a process of inviting potential suppliers for tender and comparing these suppliers based on their bids to select a supplier/suppliers that propose the most attractive offer (Van Weele, 2018). Further, risk management aiming to mitigate the consequences negatively affecting the supplier´s ability to fulfil the requirements and stakeholder management are identified to be an indispensable part of any sourcing project (Van Weele, 2018).

According to Van Weele (2018), once the purchasing requirements are translated to technical specifications, the supplier selection process is initiated and comprises of four key steps as below:

- Determining the method of subcontracting – In this step, a decision is made on whether to opt for a turnkey sub-contracting or a partial sub-contracting. In turnkey sub-contracting, the responsibility of carrying out the entire assignment is vested on suppliers and on the other hand with partial sub-contracting, various parts of the purchasing assignment are contracted to several suppliers and buying firm needs to co-ordinate these different activities.
- Preliminary qualification of suppliers and drawing up the "bidders" list – This step involves preparing a preliminary qualification document based on the purchase order specification to prequalify the potential suppliers based on their ability to fulfil the requirements. Usually, suppliers with higher vendor rating score and good performances in the past will be included in this bidders list.
- Preparation of request for quotation (RFQ) and analysis of the bids received – In this step, request for information (RFI) would be sent out to the suppliers in the bidders list to give them an opportunity to showcase their products and services and their previous projects. Based on the responses to RFI, the suppliers are short-listed to whom a RFQ is sent asking for a quotation for the specific purchase requirements. The bids provided by the suppliers in response to the RFQ are assessed to select a supplier/suppliers. Sometimes before sending the RFQ to suppliers, a request for proposal (RFP) is sent asking for a proposal from the suppliers on how they intend to fulfil the performance requirements of the buying firm (Beil, 2010).
- Selection of the supplier – Lastly after assessing the bids received from the suppliers, a decision would be made on the selection of supplier based on "Total Cost of Ownership (TCO)". A TCO is defined as "the total costs that the company will incur over the lifetime of the product".

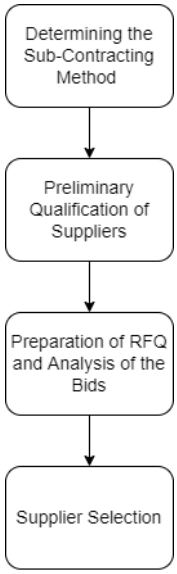

Figure 2-1 Key steps involved in the supplier selection process

Figure 2.1 shows the four key steps of the supplier selection process. In addition to the above four steps of supplier selection, Beil (2010) identifies setting up the contract terms based on the bids, negotiating the contract for the best offer, evaluating the suppliers, and then awarding the contract are part of the supplier selection process as well. To conclude, monitoring the supplier´s performance upon the agreed contract terms during the life of the contract is a part of the supplier selection process as well (Beil, 2010).

2.3 Supplier Relationship Management (SRM)

According to Moeller et al. (2006), supplier relationship management (SRM) could be defined as "the process of engaging in activities of setting up, developing, stabilizing and dissolving relationships with in-suppliers as well as the observation of out-suppliers to create and enhance value within relationships". In this definition of SRM, they refer to out-suppliers as those suppliers in the market with which the organization has no relationship in place currently and in-suppliers are referred to those suppliers that are part of the organization's business transactions. The extended purchasing model proposed by Van Weele (2018) introduced in section 2.2 comprises of supplier relationship management and performance management at its core. In this context, Lambert and Schwieterman (2012) identify SRM as one of the critical business processes that provides a structure towards developing and maintaining relationships with suppliers. They further state that SRM is a critical business process because of numerous factors such as competitive pressure, to achieve cost savings, to consider sustainability and risk and lastly, to involve suppliers in developing innovative products which ultimately helps to improve the overall performance of the organization. The SRM processes are of two levels, the processes at the strategic level deal with developing strategies to maintain relationships with the suppliers and processes at the operational level deal with developing and implementing the product and service agreements to put the strategies developed into action (Lambert & Schwieterman, 2012).

According to Touboulic et al. (2014), power dynamics is central in understanding the supply relationship management practices and it affects various aspects of an industrial relationship such as trust, conflict management, collaboration, commitment, and satisfaction. “In buyer–supplier relationships with power imbalances, the dominant organization is likely to exercise its influence over the other party and act to maintain its power, whereas the weaker organization is more likely to comply to continue accessing resources” (Touboulic et al., 2014). This role of power imbalance in the success of supply chain sustainability initiatives has been argued from both perspectives. On one hand, for instance a powerful buyer can exert sustainability requirements over its suppliers to implement sustainable practices within the supply chain, but on the other hand, this power imbalance might impede knowledge sharing between the buyer and the supplier to hinder the supply chain sustainability initiatives (Touboulic et al., 2014). Thus, it is important for organizations to consider the power imbalance within their supply chain for successful implementation of sustainability initiatives. To conclude Touboulic et al. (2014) suggest that the use of coercive power leads to short-term success and to achieve success over a long-term, interdependence and collaboration amongst the buyer and supplier is important.

2.4 Contract management

For the successful delivery of projects, goods, services a legally binding agreement which contains the set of duties, rules and regulations in-between business partners is known as a contract. (Upadhyay et al, 2021). The contract is considered lawfully valid only when all the terms within the contract are agreed by both the parties. (Uher and Davenport, 2009). The term within the contracts consists of scope of work, contract price, identities of the parties involved, schedule of execution, remedies for breach of contract, guarantees and insurances, procedures for claims and resolution of disputes. (Lowe. D, 2007). The benefit of documenting a contract helps to minimize the risk of disputes as a contract acts as a proof of the roles and responsibilities that are agreed. (Chapman and McArdle, 2020).

Within contract management there are three stages namely, pre-contractual stage, negotiations stage and post-contractual stage (see figure 2.2).

- Pre-contractual stage – Within this stage the technical specifications of the contract are drafted and then, it is communicated to the contractors. The steps involved are referred as design and engineering, and tendering respectively (Van Weele, 2018).
- Negotiations – This stage involves one or two contractors who align with the buyers’ requirements and prices. Within this stage the best competitive bid is selected, after a detailed analysis. After selection of the best supplier, a detailed planning is conducted which involves subcontracting and procurement, project execution, testing and delivery and maintenance and guarantee period (Van Weele, 2018).
- Post-contractual stage – In case of the conflicts, the legal counsel is involved in the post contractual stage which involves settling of the claims. (Van Weele, 2018)

Figure 2-2 Stages involved in contract management (Van Weele, 2018)

Within the contract negotiations phase, detailed terms regarding the roles and responsibilities should be drafted, for example the objectives to be fulfilled and goals to achieve, these roles and responsibilities within the contracts are collectively recognized as contract governance (Cheung et al, 2008). Hivronen (2019), suggests that inculcating sustainability questions, evaluations and assessments within the contract questionaries will help in promoting and encouraging the green economy. Enforcing the sustainability criteria within the contract will ensure the supplier to comply and avoid legal conflicts. This will help to promote environmental benefits. During the contractual stage setting a contract governance approach will ensure the delivery of the business outcomes. (Greaney, 2020). Issue resolution follows strategic, management and operational levels, which helps in effective decision making (Wavestone, 2016). An effective contract governance should include risk mitigation throughout the life cycle, regular performance reviews and frequent communication.

2.5 Indirect Products and Services

The procurement of any organization could be distinguished as direct procurement (DP) and indirect procurement (IP). Israel and Curkovic (2020) define DP as “Revenue-generating expenditures, or expenditures that relate directly to the product or service being sold” and IP as “Non-revenue generating expenses, or expenditures that do not relate directly to the product or service being sold”. It is important to note that there are several distinct characteristics of IP and the products and services that are sourced within IP; also referred to as “Indirect Products and Services (IPS)”. According to Israel and Curkovic (2020), DP captures majority value of the overall spend and IP accounts to 80% of the total number of purchases, but only accounts to 20% of the total spend. Thus, it could be regarded as IP mostly comprises of low value high frequency purchases with exceptions such as IT sourcing, (Israel & Curkovic, 2020).

Kapoor and Gupta (1997) note that IP deals with purchasing of a very broad range of distinct products and services for different purposes and from a wide range of supplier industries. The common categories

of products and services within IP are: Administrative expenses, Facilities expenses, Finance and HR, Sales and Marketing and Information Technology/Telecommunication expenses (Payne et al., 2011). Lastly, Israel and Curkovic (2020) note that the academic research on IP is limited to reduction of purchasing price, supplier relationship management and employee involvement in purchasing and IP being a wide and diverse area of study needs to be studied more.

2.6 Sustainable Supply Chain Management

Supply chain management (SCM) deals with the management of all the activities associated to the flow and transformation of goods from the raw material stage to the end-user including the associated information flow and integrating these activities to achieve sustained competitive advantage (Seuring & Müller, 2008). The increasing globalization and the climate crisis have placed a demand on how these activities within SCM are managed and sustainable supply chain management (SSCM) has emerged to be critical for organizations. According to the World Commission on Environment and Development (WECD, 1987), sustainable development is defined as "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Triple bottom line (TBL) approach that comprises of ensuring a minimum performance requirement on the environmental, economic and social dimensions is one of the most important frameworks to work with sustainability at the operational level (Seuring & Müller, 2008). With this background on SCM and sustainability, SSCM could be defined as:

> The management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements (Seuring & Müller, 2008).

According to Seuring and Müller (2008), it is necessary to consider multiple tiers of suppliers in SSCM than in contrast to that of traditional SCM focused on pure "economic" reasons. This is supported by Miemczyk et al. (2012) who states, "Sustainability problems are likely to stem from indirect supplier relationships that are part of the extended supply chain".

In this context, Seuring and Müller (2008) propose a framework for SSCM and according to this framework, there are triggers from regulatory authorities, customers, and various stakeholders on the focal companies to drive sustainability in their supply chains. As a result of these triggers, companies adopt two strategies that are complementary to each other; the first strategy is "supplier management for risks and performance" and the second strategy is "supply chain management for sustainable products". The first strategy deals with identifying sustainability risks and increasing the performance of the suppliers through evaluation criteria and compliance to code of conduct and on the other hand, the second strategy comprises of communicating and training suppliers towards creating a sustainable supply chain. The Figure 2.3 presents the sustainable supply chain management framework. Furthermore, Turker and Altuntas (2014) based on the discussed SSCM framework by Seuring and

Müller (2008) state that auditing and monitoring the suppliers for compliance to the code of conduct is a major task in SSCM to reduce the sustainability risks and improve supplier performance by setting up several sustainability criteria for suppliers. They also identify that communication and training the suppliers towards sustainable development as a key activity in SSCM.

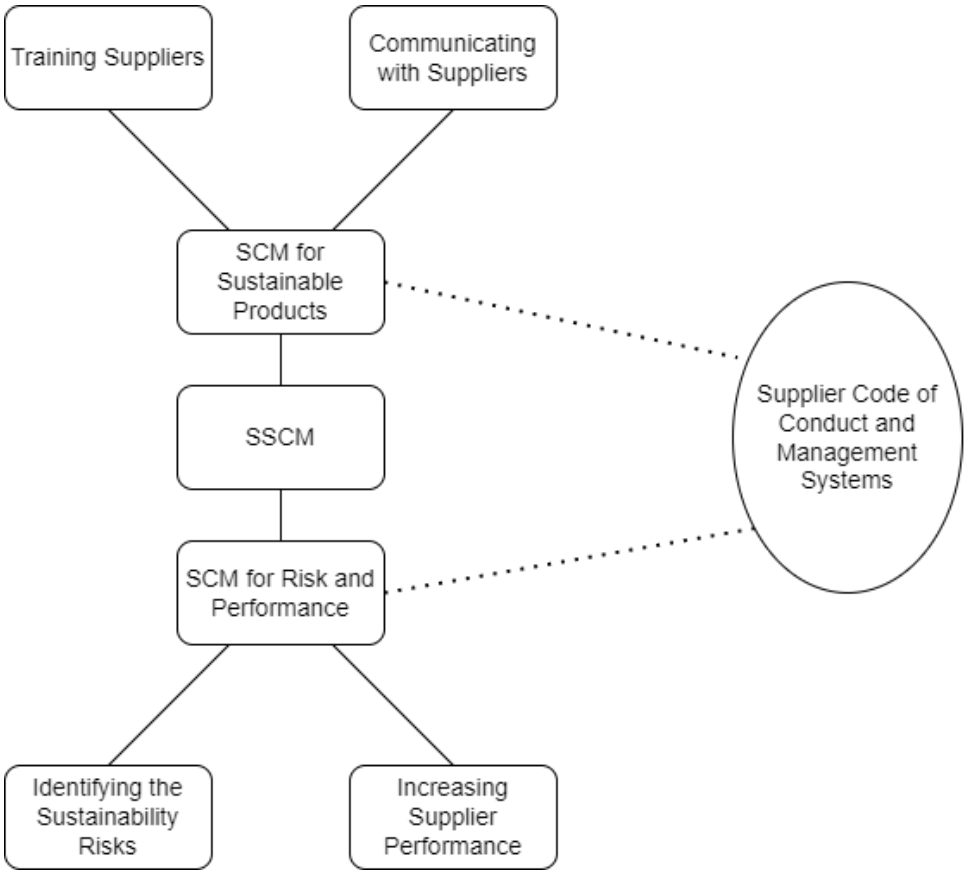

Figure 2-3 The sustainable supply chain management (SSCM) framework. (Adapted from Turker and Altuntas (2014))

It is important for several departments to integrate and align in the efforts towards sustainability and these sustainability efforts are strongly vested in the hands of the purchasing function that implements sustainable sourcing (Schneider & Wallenburg, 2012). Further, they state that an organization is only as sustainable as its upstream supply chain and thus, to achieve sustainability it is important to involve suppliers and establish environmental and social standards for supplier performance. According to Pagell et al. (2010) sustainable sourcing could be defined as "managing all aspects of the upstream component of the supply chain to maximize triple bottom-line performance, with the latter referring to a measure of business' impacts on people, profits, and the environment". In order to operationalize sustainable sourcing, organizations need to consider all the three dimensions of TBL with an exhaustive set of sustainability criteria in all its sourcing projects, not just limited to supplier selection, but also including supplier development and other activities associated to supplier management (Schneider & Wallenburg, 2012).

2.7 Corporate Social Responsibility (CSR)

According to Jones (1980), corporate social responsibility (CSR) is "the notion that corporations have an obligation to constituent groups in society other than stockholders and beyond that prescribed by law or union contract". This obligation of CSR needs to be a voluntary action and not forceful from external institutions and it should address a broad range of stakeholders such as customers, employees, suppliers and neighboring communities. (Jones, 1980)

Lindgreen and Swaen (2009) identify communication, implementation, stakeholder management, measurement and business case as key central topics while discussing CSR. It is observed that companies are increasingly using CSR communication as a tool to promote and position their brand amongst consumers and other stakeholders through their website and annual reports. However, companies need to be careful as CSR communication sometimes creates adverse effects such as stakeholder´s skepticism and cynicism (Lindgreen and Swaen, 2009). Lindgreen and Swaen (2009) further state that, CSR believes that organizations exist in networks, as a result of which they face conflicting demands from various stakeholders which needs to be translated into CSR objectives and policies, thus, "Stakeholder engagement then becomes CSR in action".

Companies in-order to achieve successful CSR implementation, need to "build bridges with their stakeholders – through formal and informal dialogues and engagement practices – in the pursuit of common goals and convince them to support the organization's chosen strategic course" (Lindgreen and Swaen, 2009). Jones (1980) identifies that it is important to consider inputs of the decision-making process in the context of CSR implementation. The confusion associated with CSR measurement as presented by Lindgreen and Swaen (2009) is supported by Jones (1980) as well. Jones (1980) states that it is very difficult to reach a consensus regarding what constitutes socially responsible behavior. Moir (2001) states that "CSR is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large". Lastly, CSR implementation creates a 'win-win' scenario for the society as a whole and the organization by establishing a competitive advantage over competitors (Lindgreen and Swaen, 2009).

Morimoto et al. (2005) examined and developed a novel CSR auditing system based on literature review and interviewing knowledgeable stakeholders. The following things are crucial for developing a robust CSR auditing system. Firstly, they emphasize the importance of including all significant stakeholder groups in the auditing process. Then, the diversity in the CSR perception of individuals and issues associated with negative screening (a tool that companies adopt to exclude business partners that they believe are unsuitable for their goals) needs to be considered while developing the CSR auditing system. Also, they suggest that companies need to be aware of the disadvantages associated with 'tick-box' approach with CSR implementation and measurement of CSR should involve both qualitative and quantitative analysis.

2.8 Circular Economy

Historically during the industrial revolution, organizations in order to make profits have put a lot of stress on material resources, energy and human labor. The business model has a blueprint of linear economy (Sariatli, 2017). The process can be summarized as take-make-dispose. In this model the focus is to procure the raw material (take), manufacture it into goods in order to have profits (make), and discard the material not used as waste even before the end of its life cycle (dispose) (Sariatli, 2017). This business model was no doubt prosperous during the times of abundant resources for industrial growth making people rise from poverty (Stuchtey et al., 2016).

The business model described above has had negative consequences, it has put pressure on the ecosystem in several ways. The overall process puts tension on the environment as the production of goods leads to high energy consumption, waste generation, emissions of toxic gases eventually depleting the natural resources and generating waste (Kenniskaarten, 2016). Linear business models cause damage to the economy in certain ways by disrupting the supply of materials. There is fluctuation of prices, geopolitical dependence on different materials and increasing demands (Kenniskaarten, 2016). World scientists have identified nine planetary boundaries, overstepping the boundaries would make irreversible changes in the ecosystem. (Rockström et al., 2009). The nine planetary boundaries are mentioned in Figure 2.4.

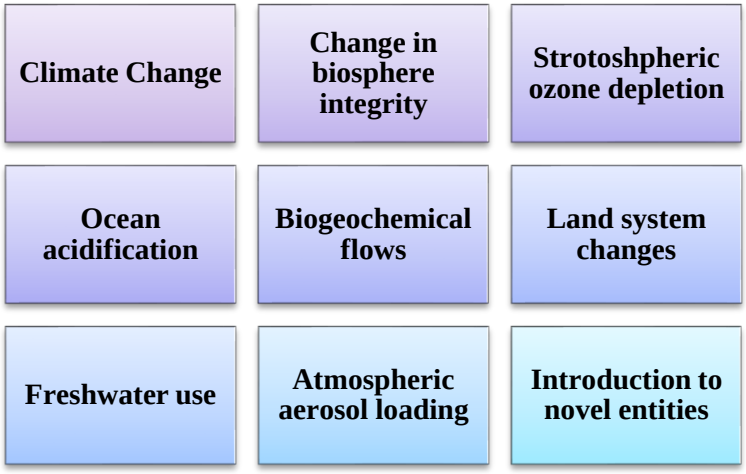

Figure 2-4The nine planetary boundaries (Source: Rockström et al., 2009)

In order to put ease on the above-mentioned negative consequences and decouple the economic growth from the resource depletion and eventually ease the environmental concerns, a proposed business model is known as circular economy. (Korhonen et al, 2018). Circular Economy model presents a redesign of the traditional linear model which proposes a closed loop resource flow. This process will help to preserve the environment and reduce waste. This is obtained by increasing the end of life of the products or by recirculating it back into the loop (Hollander et al. 2017).

There are three broad categories of strategies in order to obtain circularity of products. A strategy that will narrow the resource loop, for example by reducing the waste in production. The second strategy

helps to slow the resource loop by repairing, remanufacturing, reusing etc. and a third strategy is meant to close the resource loop by recycling

	Circular Economy			Strategies	
		Smarter product use and manufacture	R0	Refuse	Make product redundant by abandoning its function or by offering the same function with a radically different product
			R1	Rethink	Make product use more intensive eg by sharing a product
			R2	Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources
		Expand lifespan of the product and its parts	R3	Reuse	Reuse by another consumer of discarded product which is still in good condition and fulfill its original function
			R4	Repair	Repair and maintenance of defective product so it can be used with its original function
			R5	Refurbish	Restore an old product and bring it up to date
			R6	Remanufacture	Use of discarded product in a new product with same function
			R7	Repurpose	Use this discarded products or its parts in a new product with different function
	Linear Economy	Useful application of material	R8	Recycle	Process material to obtain same or lower quality
	Linear Economy		R9	Recover	Incineration of material with energy recovery

Figure 2-5 The 9R framework of circular economy (Source: Kirchherr et al, 2017)

The 9R framework (refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, recover) in Figure 2.4 proposes the way circular economy can be implemented, however the 3R framework (reduce, reuse, recycle) is the core operating principle. (Kirchherr, 2017).

Implementing circular economy also brings positive impacts on the business. It provides an opportunity for profits to be generated. As the organizations implement circular economy it aligns the business with

the values of conscious customers and promotes the brand towards positive values, this increases customer loyalty. Circularity provides a reduced volatility with an increased assurance towards linear supply. (Volvo Group, 2021f) This opens doors for new demands within the business segment.

3 Method

This section describes the research strategy in conducting the study, which includes the research design and method used to answer all the research questions. Firstly, the research approach and process are described followed by the methods that have been used to gather data. Lastly, the validity and reliability of this study is described

3.1 Research Strategy and Approach

This study focuses on how the Digital and IT Purchasing department of Volvo Group Trucks Purchasing (GTP) can improve their sustainable procurement strategies within the sourcing of network and telecommunications (N&T) services.

Quantitative and qualitative research are the two most common research strategies. According to Bryman and Bell (2013), quantitative research emphasizes quantification in the collection and analysis of the data, whereas qualitative research on the other hand emphasizes the words rather than the quantification in the collection and analysis of the data. This study adopts a qualitative research strategy that includes interviews to collect primary data.

Research approaches are mainly of three types, namely i) inductive, ii) deductive and iii) abductive (Bryman and Bell, 2013). An inductive research approach involves inferring generalizable theory from observations, while a deductive approach makes use of theory as its foundation upon which observations are made. On the other hand, an abductive research approach is a mixture of inductive and deductive research approaches (Bryman and Bell, 2013). The inductive research approach is adopted for this study as the authors collect data from interviews and other primary and secondary sources to make conclusions.

Bell et al. (2019) presents five types of research design, namely, experimental design, cross-sectional or social survey design, longitudinal design; case study design; and comparative design. The choice of research design influences the data collection and analysis of a research study. According to Eisenhardt (1989) and Gerring (2004), a study with a focus on the specific settings and properties of a single company can be called a case study. A case study can be deemed as a research methodology when the problem in hand is to address improvement of a process specific to an organization. This study adopts a case study research design as the objective is to analyze and recommend improvement strategies to a specific setting of an organization. This is supported by Dubois and Gadde (2002), who notes that the case study research design facilitates a deep understanding of the interaction between a phenomenon and its context particular to that case. Further, in a case study, interviews along with observations and information from the case company help in understanding a phenomenon at the case company. As explained earlier, this study focuses on the Digital and IT Purchasing department within Volvo Group Trucks Purchasing. The study comprised internal interviews at the case company, external interviews with three N&T service suppliers, and a literature review to understand and mitigate the complexity involved in the research topic.

3.2 Research Process

The six main steps in conducting qualitative research are general research questions, selecting the scope, relevant data collection, data interpretation, conceptual and theoretical work and further data collection, and writing up the conclusions as a final step (Bell et al., 2019). The first two steps of this study were provided by the Volvo Group, with the aim being "How to buy N&T services in a sustainable way?". The third step, data collection was performed through conducting interviews and collecting primary and secondary data, which are detailed in section 3.3. The interviews conducted were recorded and transcribed for the purpose of data interpretation. Then, a literature review was conducted before and during the data collection process which covers the fifth step. The final step was completed by providing certain strategic recommendations to Volvo Group. The research process adopted for the purpose of this study is presented in figure 3.1.

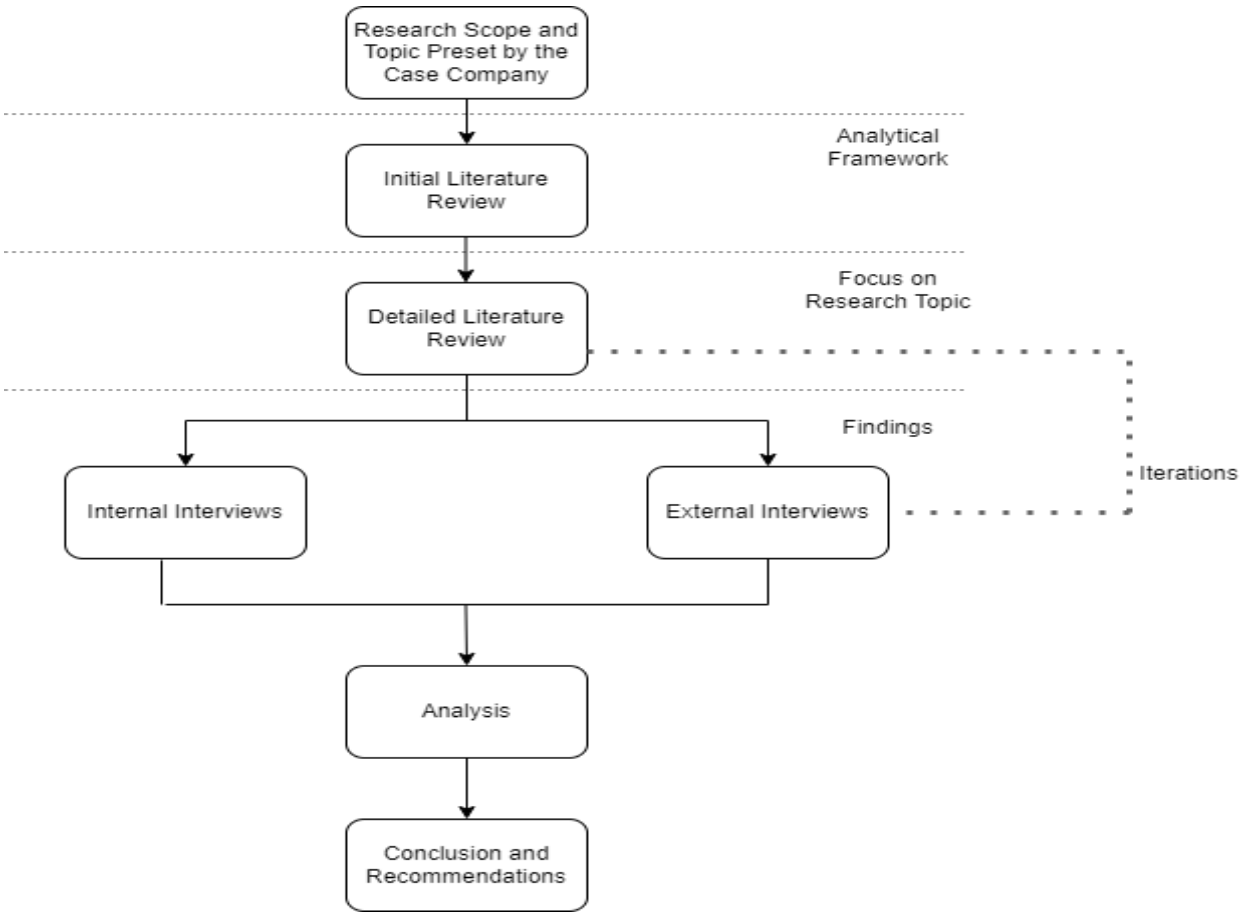

Figure 3-1 Research process opted in this study

The research scope for this study was pre-set by the case company, i.e., sustainable sourcing of Network and Telecommunications (N&T) services. Based on the research topic, an initial literature review was conducted to study the broader theoretical framework governing the research topic. Then, a detailed literature review was conducted to understand the operations and the supply chain of N&T. Identifying the sustainability risks within the N&T industry and its mitigation was also a part of the detailed literature review. This was then followed by internal interviews and supplier interviews that were the

primary source of the data used in the study for analysis and conclusions. It is important to note that, to conduct supplier interviews, the findings from the detailed literature review were reviewed back and forth to collect an extensive amount of data.

3.3 Data Collection and Sources

This study primarily used data collected from interviews (both internal and external). In addition to the internal interviews within the case company, internal documents were reviewed to gain a deeper understanding of the present sustainable sourcing strategies that comprise of supplier evaluation and supplier governance. Further, a review of the sustainability reports of the suppliers that were interviewed in the study along with the interview data provided an in-depth understanding of various risks involved and their mitigation within the N&T industry.

3.3.1 Secondary Data

According to Bryman and Bell (2013), any data that is collected by other researchers or organizations is classified as secondary data, which can be used for both quantitative and qualitative research. Using secondary data in a research study has both advantages and disadvantages (Boysen et al., 2021). The advantage of using secondary data is that time and costs associated with data collection is saved and data can still be of a high quality. On the other hand, a disadvantage with using this secondary data is that it might require additional processing because of the varying level of details, its purpose, and the method in which it was collected. The secondary data used in this study mainly comprised of internal company documents and the annual sustainability reports of the suppliers that were interviewed in the study.

The internal documents of the case company used in the study are the presentations and documents that are used to train and share the knowledge to the company´s employees. The case company's supplier code of conduct, sustainable strategies training, and supplier governance training are described in various internal documents which provided data for the study. The first two internal documents provided an understanding of how the case company ensures sustainability criteria in the supplier selection and how it conveys sustainability demands on the suppliers. The latter document helped the authors in gaining knowledge on how supplier performance is followed-up throughout the contract lifecycle of a supplier relationship. The data from these documents were used in this study to support the data gathered from internal interviews. The purpose of collecting data from these internal documents was to get an overall understanding of the sustainable procurement strategies implemented at the case company. This data helped in understanding the various tools and approaches used by the case company for sustainable sourcing. Understanding the present sustainable sourcing approaches was key to the study as the objective of the study is to recommend additional strategies to facilitate robust sustainable sourcing practices.

Recently published annual CSR reports and the company websites of the three suppliers that were interviewed in the study contribute as secondary data to this study. The data from these sources

comprised the overall sustainability strategies used by the supplier companies. The secondary data collected from the CSR reports and the websites helped the authors to understand the sustainability risks within the N&T industry and how these risks are being mitigated by the suppliers. The secondary data gathered from these sources contributed to the understanding of the N&T industry risks and the various key performance indicators (KPIs) used to monitor sustainability performance. These CSR reports are of high quality as these are the reports published to the public and follow standard guidelines of reporting, which in turn assures the quality of the data gathered from these reports. To conclude, the data gathered from these sources was used as a foundation for the supplier interviews to investigate the criticality of the sustainability risks and gain a deeper understanding of the risk mitigation strategies.

3.3.2 Primary Data

According to Bryman and Bell (2013), data collected for the sole purpose of the research can be classified as primary data. It was found to be important to collect primary data through interviews in this study. In this study, interviews were conducted both with personnel internal to the company and external personnel from the supplier companies. Convenience and snowball sampling are the two methods used for selecting the interviewees in the study. The advantage of using convenience sampling is the level of accessibility and on the other hand, snowball sampling allowed the authors to establish contact with people relevant to the research topic through a pre-selected group of relevant people (Bryman and Bell, 2013). The authors believe that conducting internal and external interviews was very critical in understanding the complexity of the research topic. Also, conducting the internal and external interviews helped the authors in analyzing the effectiveness of sustainable sourcing approaches practiced at the case company. Further as this study investigates the sustainability risks present within the supplier's operations and their supply chain, it was extremely important to meet the suppliers and interview them. This provided the authors with information on what the suppliers perceive to be the critical sustainability risks and how they mitigate these risks. The interview method is explained in the next section

3.3.3 Internal Interviews

The internal interviews with people at the case company were conducted at the start of the study and the approximate duration of these interviews was between 30 minutes and one hour. The interviewees selected for this phase were very diverse with respect to their specialization related to sustainable procurement. The interviews were of an exploratory nature to investigate the various sustainable procurement practices and how these practices are used in a sourcing project and to interact with the suppliers. Table 3.1summarizes the internal interviews. The interviewees in this phase hold different positions and hence, the authors believe that this contributed to gaining information from different perspectives on the same subject.

Table 3-1 Summary of Internal Interviews

Position	Major Discussion Topic	Length
Head of Responsible Purchasing	Responsible Purchasing Strategies, their Implementation and Guidance for this Study	40 mins
Sustainability Manager	Responsible Purchasing Strategies and their Implementation	30 mins
Senior Buyer (Casting and Forging)	Responsible Purchasing within Direct Procurement	30 mins
Supplier Evaluation Model Specialist	Onsite Audits	70 mins
Segment Leader (Telecommunications Services)	Responsible Purchasing within Indirect Procurement	Regular Interaction
Senior Service Delivery Leader (N&T Services)	Responsible Purchasing within Indirect Procurement	Regular Interaction

The interviews conducted were semi-structured with a pre-defined interview questionnaire. However, the interview questions were carefully modified according to the responsibilities of the interviewee before each interview. The interviews with employees from the sustainability department focused on determining the case company´s sustainability strategies and how these strategies are translated into actions at the operational level in each sourcing project or within supplier interactions. The interview conducted with the senior buyer helped the authors in understanding how the sustainability strategies are implemented within the case company´s direct procurement. Further, the interview with the supplier evaluation model specialist provided the authors an understanding of the supplier evaluation model of the case company. The major focus of this interview was on the onsite audits that the case company conducts. Lastly, regular interactions with the Telecommunications segment leader and the N&T senior service delivery leader helped the authors get a detailed understanding of the sustainable procurement strategies practiced within case company´s indirect procurement such as N&T services.

3.3.4 External Interviews

In addition to the internal interviews with the employees of the case company, external interviews were conducted with N&T service suppliers. The interview questionnaire for the external interviews was also semi-structured. The interviewees were provided with loosely structured questions several days before the interview, which helped them to prepare and openly discuss during the interviews. Table 3.2 summarizes the conducted external interviews

The first meetings with the suppliers were all very short. The authors introduced the suppliers to the thesis topic and how the authors and the case company would like to collaborate with the suppliers for

the purpose of this study. After the introductory interviews, the later interviews and follow-up emails focused on the research topic. In addition to literature review, investigating the annual CSR reports of the suppliers was helpful and supportive for data collection in this phase. Based on the findings from the literature review and the annual CSR reports of the suppliers, the authors conducted the interviews with a focus on understanding the critical sustainability risks within the N&T industry and how the suppliers are taking actions to mitigate these risks. This knowledge on the sustainability risks of the industry helped the authors in providing the case company with certain strategic recommendations. Based on these recommendations, the case company can develop their sustainable sourcing strategies by addressing the specific risks associated with the product or service procured. Lastly, the external interviews also contributed to collecting data regarding how other customers of the interviewed suppliers were collaborating for sustainable sourcing of N&T services. The findings on the best practices of other customers were found to be beneficial for the case company in improving their sustainable sourcing strategies.

Table 3-2 Summary of External Interviews

Major Discussion Topic	**Supplier (Length)**
Introductory meeting	AT&T (20 mins), Telia (20 mins), Tele2 (20 mins)
N&T sustainability risks and mitigation based on the findings of their annual CSR report.	AT&T (60 minutes), Telia (50 mins), Tele2 (50 mins)
N&T sustainability risks and mitigation based on the findings of literature review and other supplier interviews	Telia (70 mins) and Tele2 (60 mins)
Responsible sourcing strategies of other customers of the suppliers	AT&T (Email) and Telia (30 mins)

3.3.5 Literature Review

The authors conducted a detailed literature review in order to gain an in-depth knowledge about the research objectives and integrate the theoretical framework with the research topic. The idea of literature review is to read and reflect the past research work by scholars, identify the central themes to solve the research objectives and support the arguments through the literature data (Gregorio, 2000).

The literature review was conducted in two phases, one for devising the framework of the thesis and the second for getting in-depth knowledge about the research topic. The framework study comprised of major topics such as procurement, supplier selection, contract management and sustainable supply chain management. After developing the analytical framework that supports the study, the authors conducted a detailed literature review assessing the critical sustainability risks within N&T and their

mitigation. The analytical framework and the in-depth study helped the authors to frame questionnaires for the supplier interviews.

The literature review was carried out by identifying and analyzing research articles, white paper reports, news articles and documents discussing the industry standards for the N&T industry. The literature review was carried out by searching through the Chalmers library, Google Scholar and news articles published by different actors in the N&T industry. The keywords that were used for carrying out the literature review were: Sustainable Sourcing, Sustainability Risks, Risk Mitigation, Network and Telecommunications (N&T), Telecommunications Sustainability Questionnaire, IT Purchasing, Telecommunication Operators (TCOs).

3.4 Ethics

As mentioned above, within this study the authors conducted several interviews with internal and external stakeholders. The information from the interviews was documented and analyzed to answer the research questions. The authors conducted the interviews and the research in a professional, ethical, and honest manner. For a research study to be carried out in an ethical manner four major aspects should be taken within consideration, namely- harm of participants, lack of informed consent, deception, and privacy. (Bryman and Bell, 2013).

During the research, interviews were the only involvement of the participants, and the research did not involve any experiments with the participants. Due to this, it seems safe to conclude that there was no harm physically to the participants involved. The interviewees were presented with the questions before the interviews and were asked for their most suitable dates for conducting the interviews. Hence, the interviews were conducted with the most comfortable zone for the participants involved. Initiatives like this ensured there wasn't any mental stress or harm of participants during the research.

The introductory meeting with the suppliers (participants) involved a brief description of the thesis and how their collaboration could be value adding was mentioned. The participants were provided with information regarding the author's motives and the expectations of the participants. There was clearly no lack of information or issues regarding consent with the participants involved.

During the research, the authors treated the participants with integrity and a high respect for confidentiality and anonymity. The interviews were recorded for the purpose of thesis with the consent of the interviewees. Due to the signed NDA between the suppliers and Volvo Group confidentiality was respected, and the results were published in a fair and honest manner.

3.5 Reliability and validity of the study

3.5.1 Reliability

The reliability of the research is defined as the extent to which the data generated is considered accurate. Research reliability is categorized into external reliability and internal reliability. The degree to which the research study can be replicated is known as external reliability. Internal reliability is defined as the extent to which the authors are in agreement with their research data. (Bryman and Bell, 2013).

During the research the data was gathered from interviews. The interview data is somewhat found to be biased as the interviewees will seldom mention the shortcomings within their work. For the reliability of the research, both the authors were always present for meetings. The meetings were recorded with the consent of participants, in order to avoid missing even a small piece of important information. The interviews with the external stakeholders were conducted with similar designations, that is in our case the sustainability managers were interviewed. However, it was observed that they were unaware of the technical specifications for few of the projects related to sustainability. This will affect the data generated for the research.

3.5.2 Validity

The validity of the research refers to the integrity of the results and conclusion. Validity can also be categorized into internal and external validity. External validity refers to the extent to which the research can be generalized and whether the analysis and conclusion can be valid in other cases than the research case (Bryman and Bell, 2013). Although the sustainability risks and the mitigation approaches identified in the study are associated with the N&T industry, data collected on sustainable sourcing of these services are specific to the case company and thus, the authors believe that it is subjected to low external validity.

During the research a triangulation approach was used by the researchers to validate the data. Triangulation means that more than one approach is used for data collection. (Creswell, 2009) The authors collected the data through interviews, news articles, supplier reports etc. The data was researched from more than one article, verified with news articles etc. Also, the data gathered from supplier websites was validated with the interviewees

To further ensure data validity and reliability, the main recommendations (i.e., the RFP questionnaire) was sent to the suppliers. The suppliers were asked to rate the questionnaire for relevance and criticality from their point of view and also to provide their comments on each question. The response and feedback from the suppliers ensure that the study conducted by the authors is valid and reliable. The major takeaways from the supplier feedback are as below:

- It is important to consider the reduction of scope 3 emissions rather than just limiting to scope 1 and 2 emissions. The scope 1 and 2 emissions are majorly related to electricity consumption and shift towards non-renewable energy sourcing reduces these emissions significantly, this is especially true for the TCOs operating in the European region.
- It is important to investigate and demand certifications rather than merely asking about their projects to mitigate the risks. Also, this use of certifications enables pragmatic comparison between two suppliers.
- Questions related to energy efficiency projects, energy reuse, dynamic power management system, water consumption, network infrastructure sharing largely depends on the TCOs operational size, geographical location, amount of time present in the industry and many other

such factors. Hence, more investigation on these questions needs to be performed by collaborating with the suppliers that enables addressing the core sustainability risks present within these questions. Also, the case company needs to consider that the feedback provided are from the TCOs present in Europe and the USA and hence, few questions are relevant as it is for TCOs present in other regions.

4 Network and Telecommunication

Telecommunications is a support function when it comes to the automotive industry. It is seldom or never a core competency for such industries. Hence, procurement of telecommunications services from an external service provider is an obvious choice (Lindskog, 2005).

When the data is transferred through the electromagnetic receptive devices through the electromagnetic signals from a distance it is termed telecommunications. Whereas the process which involves the interconnection of the devices through a physical medium like cables, wires and atmosphere to a main system or servers, it is known as networking. In the case of telecommunications, the hardware required is the satellite system, fiber optic cable, coaxial cable etc. Whereas, in the case of networking the hardware required is routers, wires cables, hubs etc (David, 2013).

This section on Network and Telecommunication (N&T) introduces the operation of mobile and fixed telephony services followed by the supply chain of the N&T industry. Later, the sustainability risks within the N&T industry and their mitigation are explained in detail.

4.1 Mobile and Fixed Telephony Operations

When a person communicates with their mobile, the microphone picks up the voice of the user. The voice is converted into a digital signal in the forms of 0s and1s with the help of sensors. This signal is transmitted by the built-in antenna of a mobile in the form of electromagnetic waves. When the electromagnetic waves are transmitted to the end users' phone, a phone call is established. However, in case of very long distances or other environmental and surrounding factors the electromagnetic waves are incapable of transmitting. In effect to this the cellular technology has been established with cell towers. (Lesics, 2018). A geographical area is divided into different hexagonal cells each containing mobile base stations. (Hatzis et al, 1999). These cell towers are connected to one another by optical fiber cables in order to provide connectivity. The electromagnetic waves generated by the user's mobile antenna are picked up by the antenna in the nearest cell tower. These waves are converted into high frequency light pulses which are transmitted by the optical fibers to the base transceiver station (BTS) (Lesics, 2018).

The BTS processes and sends the pulses to the destination tower of the end users via optical fiber. The antenna in the destination tower again converts the pulses to electromagnetic waves which are emitted and picked up by the end users' mobile phone antenna. These electromagnetic waves are once again converted back into sound waves with the help of sensors in the mobile. (Teracom Training institute, 2014)

Base station controller (BSC) allows one or more BTS to communicate with mobile switching centers (MSC). The MSC contains all the information registered in a sim card along with the user's location, service plans, activity status etc. for the user/subscriber. The MSC is used to route calls from base stations and public switched telephone network (PTSN) from mobile phones and landlines. In the case of different networks (e.g., Tele2 to Telia) or different modes of communication (mobile phone to

landline) another MSC called gateway mobile switching center (GMSC) is present. Figure 4.1 shows how a GMSC switches the call to PTSN. (Cadogan, 2016)

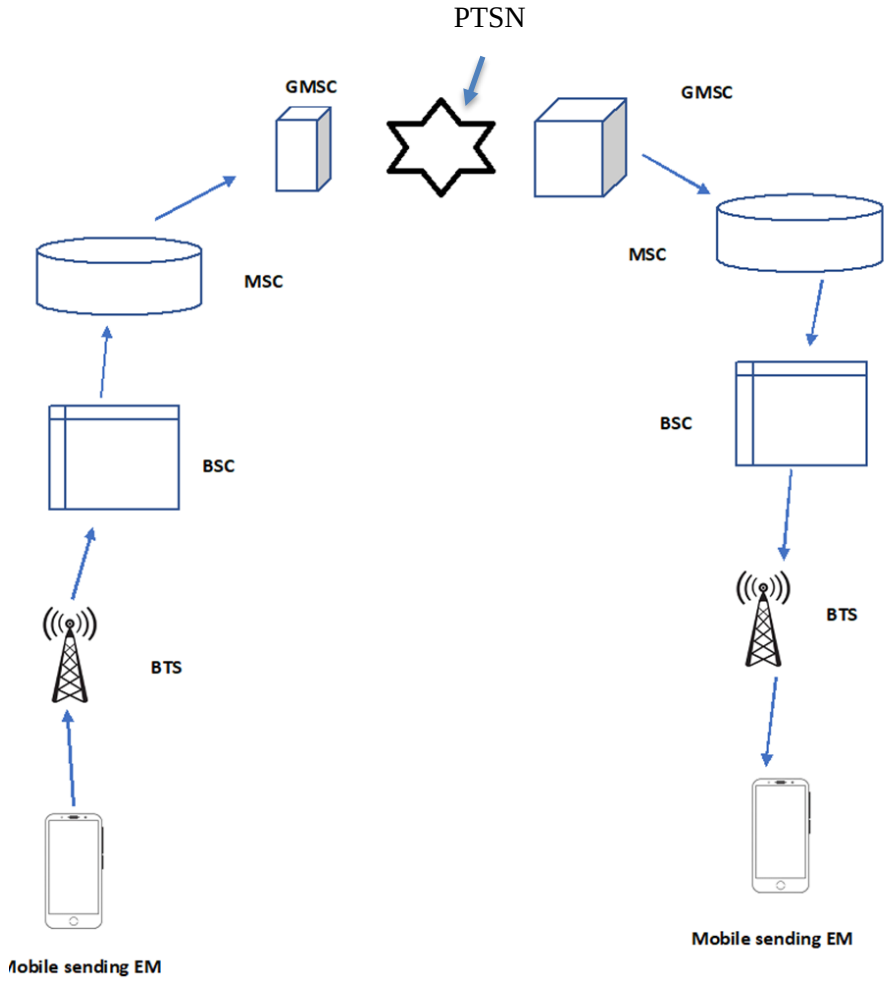

Figure 4-1 N&T operations (Source, Cadogan 2016)

4.2 Telecommunication Industry Supply Chain

The actors in the telecommunication supply chain are of a very diverse nature. Equipment manufacturers or vendors that specialize in the technology involved in the physical network hardware equipment are one such type of actors within the telecommunications supply chain (Çanakoğlu & Bilgic, 2007).

Yu et al. (2008) in their study on the Chinese ICT (Information and Communication Technology) industry mention that the ICT eco-system comprises of the following actors: Operators, Equipment Providers, Application Providers, Service Providers, and the Content Providers. As noted earlier, equipment providers are responsible for providing the network infrastructure and tailored handsets. On the other hand, application providers are responsible for providing the software solutions as per the requirements of the telecommunication operators. Ultimately, with the help of these various actors, the telecommunication operators own the network infrastructure and provide the mobile and fixed telephony services. These operators are the focal companies in the supply chain (Yu et al., 2008).

Cassivi et al. (2005) in their study on the telecommunication industry value chain propose that it comprises of four major players with network operators at one end and sub-assemblers that specialize in manufacturing of components and parts of hardware on the other end. The system integrators such as Ericsson, Nokia Networks and Huawei and the electronic manufacturing specialists (EMS) as the second and the third layer. These system integrators and the EMS are combinedly referred to as equipment providers by Yu et al. (2008). Traditionally, these system integrators owned much of the value chain. However, in the recent times, the system integrators are focusing on the knowledge-based portion of the value chain such as R&D and integrating solutions to customer requirements and more and more manufacturing activities are being outsourced to electronic manufacturing specialists (Cassivi et al,. 2005). This is further supported by Agrell et al. (2004) as they note that the increased outsourcing has brought a shift in the network and telecommunication industry's supply chain. Further, this has increased the share of manufacturing and assembly by the electronic manufacturing specialists and their activities majorly comprise of labor-intensive product assembly. Apart from the physical product providers, there are other actors such as installation service providers.

The network equipment providers are the major suppliers in the telecommunications supply chain. Zhu and Pasadilla (2016) presented a comprehensive view on the multi-tier supply chain with respect to these network equipment providers as shown in Figure 4.2. The contract manufacturers and network equipment manufacturers referred to by them are similar to electronic manufacturing specialists and system integrators presented by Cassivi et al. (2005) respectively.

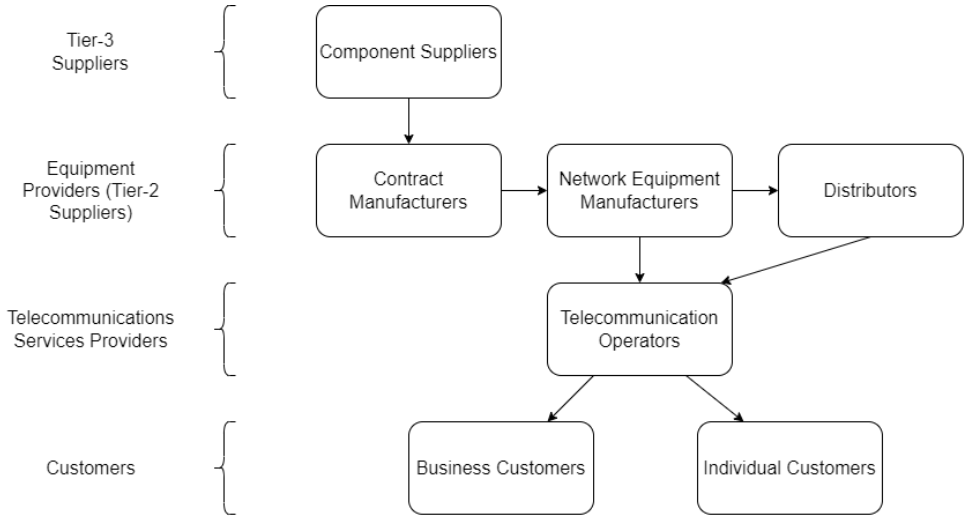

Figure 4-2 Network and Telecommunications Industry Supply Chain (adapted from Zhu and Pasadilla (2016))

Asokan (n.d.) highlights the various supply chain activities that is the responsibility of a network and telecommunication operator such as Airtel. These supply chain activities with respect to network hardware equipment include supply and demand planning, inventory and asset management, warehouse management and logistics management. Further, activities with respect to network infrastructure

include construction, maintenance, and field-force management. It is important to note that apart from the network equipment suppliers, there are other supply partners to the telecommunication operators such as the construction and maintenance providers of network infrastructure and recycling contractors.

4.3 Sustainability in Network and Telecommunication Industry

The author of the book "Hot, Flat and Crowded" Thomas Friedman writes about the impacts of urbanization on the climate. Due to urbanization, catering to the needs of the rapidly growing population has created a significant amount of negative impacts on the planet. Ultimately making the planet a hot, flat, crowded and dangerously unstable place to live. The maximum amount of climate damage was caused in the 20th century due to an increase in GHG emissions created by humans. This is observed in the form of an increase in temperature, rising sea level, melting of snow and ice. (Sutherland, 2009). Several scholars and scientists warned the governments regarding the impacts and the concern regarding GHG emissions and climate change. To reduce the climate impacts, an intergovernmental negotiating body was developed known as United Nations Framework Convention on Climate Change (UNFCCC) at Rio Summit 1992 to develop the international policies with respect to global warming. The main motto of this body is to stabilize GHG and its impacts on the climate. To strengthen this, on December 3, 1997, Kyoto Protocal was adopted and is considered as a milestone. (Batagoda, 2002). The Paris Agreement in 2015, is also a part of the framework of UNFCCC, this was implemented as a result of COP 21 summit. (UNFCCC, n.d.).

4.3.1 Climate Impact Within Telecommunications Operations

Telecommunications is one such sector which contributes to a high amount of GHG emissions and hence climatic changes. The telecommunications sector has expanded vastly due to the technological innovations and the benefits incurring from this sector (Matthew et al, 2010). The ICT sector contributes approximately to 5% of global annual GDP (Mohanty & Moreira, 2014) According to the European Telecommunications Network Operators' (ETNO) Association, in the year 2020, the telecommunications sector alone contributed to 2.6% of total global carbon dioxide (CO2) emissions (White, 2021). The global power usage of ICT is estimated to be 4% of the total global power for its operations and the extensive use of fossil fuels to produce this energy is leading to their depletion (Mohanty and Moreira, 2014).

Horvath (1999) while discussing the environmental impact associated with telecommunication industry as a service sector notes that "In general, while these service sectors generate little pollution at the point of production, the indirect environmental effects can be substantial". The embedded emissions from the manufacturing processes and transportation of these N&T components contribute to the overall emissions. (Sutherland, 2009). In the case of N&T, the GHG emissions are in varying extents, for instance, within the base stations, cabinets, and network sites there is a heavy usage of fluorine compounds used as coolants for cooling equipment. In the case of manufacturing processes of semiconductors for telecommunication equipment a very powerful range of fluorine gases are used.

Even though approaches have been made for chemicals to avoid ozone damage by replacing some harmful chemicals, however, the use of fluorine compounds stills stays unavoidable. Apart from their usage within components, accounting must be considered in case of losses to the atmosphere through the sealings and seepages of the system during operations. (Sutherland, 2009).

Telecommunications operators usually do not deal with the hazardous chemicals directly. However, within the network equipment like backup power systems, air-conditioners make use of hazardous chemicals and in a way, telecommunications operators are associated with it indirectly. The recommended actions in order to deal with the hazardous chemicals in telecommunication sectors is to implement a management system to handle the hazards, and sustainable sourcing of certified electronic equipment. (IFC, 2007) The air-conditioners containing ozone depleting substances should be phased out.

There is high growth in the N&T sector due to expanding operations of the ICT sector and thus, an increase in the N&T customer base. The scenario of emissions is different with respect to the economic development of the countries. For example, in the case of some developing countries, the operators make use of diesel generated electricity for the network sites and base stations. The emissions from diesel generated electricity against that of the hydroelectric plant in a developed country will be substantially different (Sutherland, 2009). The major environmental impact from the ICT sector is from energy consumption and followed by energy emissions. (Canfora et al, 2020)

Within the telecommunication sector, energy consumption is concentrated at the periphery of both the wireline and wireless access networks and thus, implementing energy savings at the periphery offers a huge potential for energy savings. (Rittenhouse et al, 2011). Wireless access is growing rapidly, and the predominant contributor for energy wastage is the energy transmission through air. In the case of wireline transmission, it is access, routing and switching that consumes a lot of energy. As the amount of data transmitted increases there is a higher consumption of energy during routing and switching. (Tucker, 2012). For wireless access, the efficiency could be improved by bringing the transmitting and receiving antennas closer together (Rittenhouse et al, 2011). Energy consumption accounts for being a major contributor to the operating expenditure of the network, according to the white paper reports of Nokia (2016) only 15% of the energy spent is utilized for forwarding the bits whereas 85% of the energy is wasted in losses due to inefficiencies.

According to technical analysts, the base stations are the most energy intensive part of a typical cellular network. The base station accounts for 57% of total power consumption. (Huawei, 2020). Within the base station power amplifiers and transceivers contribute to the largest energy consumption. (Huawei, 2020) Saving power in base stations is therefore the primary focus in green cellular networks. The main goal of designing green base stations is to save energy and reduce power consumption while guaranteeing service and coverage for users (Singh et al, 2012)

In order to achieve the goals of the Paris agreement, EU Eco-Management and Audit Scheme (EMAS) was a tool developed by the European Commission for the organizations to improve their environmental

performance (Canfora, 2020). Similarly, EMS (Environmental Management System) is a tool which helps to improve the environmental aspects of the operations of organizations. (European Commission, 2016). This framework helps to provide guidance to reduce the environmental impacts and increase the organization's operative effectiveness. The EMS is based on ISO 14000 and EMAS (Canfora et al, 2020). Implementing these regulations and policies will help the organizations and countries to avoid the harmful impacts to the environment and act in a more responsible manner. The objective is to identify and mitigate the risks based on these regulations and policies. In the case of the N&T sector the adaptation and implementation of EMS will help to reduce the environmental impact. The main objectives of EMS are analyzing the environmental impacts, setting the targets for the organization to reduce impacts, establishing programs to counter the impacts and reviewing the progress. (Canfora et al, 2020)

Companies are using the following approaches to make the telecommunications sector more sustainable:

- Use of renewable energy- To minimize the use of fossil fuels, use of renewable energy in the form of solar, wind, hydroelectric is recommended as it significantly reduces the carbon footprint associated with electricity production (Canfora et al, 2020) However, the limiting factor for the usage of renewable energy is the uncertainty of availability and lack of effective power storage (Mohanty &Moreira, 2014). Due to the manufacturing improvements in the hydrogen fuel cells (that convert hydrogen to electricity) there is a high demand for this alternative usage of power source, due to which reliability and longevity is increased. (Singh et al, 2012). As a protection against the uncertainty of solar or wind energy, sites deploy a hybrid system of solar and wind energy that is a solar photovoltaic cell with a wind turbine. (Singh et al, 2012)
- Energy efficient equipment – Radio base stations are devices present in several locations and could be considered as the major backbone enabling seamless telecommunication processes (Madon, 2021). During the low traffic period or idle state, the base stations cause significant energy wastage in order to send mandatory signal for synchronization, system information etc. (Frenger &Tano, 2019). In such situations, effective power on/off for the device will significantly reduce the energy consumption. (Singh et al, 2012). During low traffic, bandwidth adaptation can be implemented to achieve lower consumption of energy. However, due to the capital investments required, these energy efficiency equipment is not viable from the business perspective. (Matthews et al, 2010). Matthews et al, (2010) mentions in their paper that deploying new energy efficient infrastructure will help to fulfill the increasing demand and deploying support equipment to existing infrastructure with power saving options is viable and would help in power reduction. One such way is the use of Passive optical networks, which helps to divide the optical bandwidth to multiple locations.

- Flexi base station- This is a software defined base station, which helps in reduction of the site energy consumed. Being a portable base station with less size and weight, it can be placed in an open atmosphere for natural cooling, which will help in energy reduction for air conditioning equipment. This type of base station further lowers the carbon footprint with software updates in the near future. (Singh et al, 2012). The software updates help in the way the data is processed and transmitted, hence optimizing the data will help in considerable energy reduction. (Canfora et al, 2020)
- Site designs- Well planned site designs such as locating the base stations in an open atmosphere to lower the energy required for cooling results in a lower carbon footprint. Another green cooling approach is to make use of liquid cooling, that is the use of water to cool the equipment by either convection or conduction. (Nokia, 2022) Also using sustainable material at the site lowers the environmental impact.

  A typical network tower is made up of steel or wood with a concrete foundation. The major components for the tower, like steel, concrete cause environmental impacts during its production phase to the end of life (Chase, 2022). This causes air pollution, soil acidification, water pollution etc. In order to combat the environmental impacts, using glass fiber as a material for the towers is a climate positive choice. The characteristics of glass fiber such as its mechanical strength, thermal resistance, stability, non-corrosive etc prove to be more efficient than traditional steel towers. The glass fiber tower does not require maintenance for rusting or environmental degradation. Glass fiber being lighter in weight is easy to transport followed by lower emissions through the vehicle. After end-of-life glass fibers are easy to recycle, and the by-product can be reused. Hence the overall process is less energy intensive and creates less environmental impact. (Chase, 2022). For example, Tower Tube by Ericsson is made of concrete which has lower environmental impact in comparison to traditional steel. It is a modern design to encapsulate all the base station equipment and antenna. (Singh et al, 2012). Use of optical fiber or Free space optics helps to carry multigigabit data traffic, supporting high bandwidth without much maintenance is another example.
- Carbon Neutrality – When the company activities balance their generated amount of co2 level by removing equivalently from the atmospheric co2 is known as carbon neutrality. (Bernoville, 2021) This can be done by investing in renewable energy projects or by using carbon sequestration. It is the process to capture and store atmospheric carbon dioxide. It can be achieved by direct or indirect carbon sequestration. When the carbon is reduced from the point source of its origin by either absorption, Membrane separation, Desiccant adsorption, or Cryogenic Separation. The easiest and most widespread method adopted is chemical absorption by chemical like amine solvents. Climatic carbon dioxide can be removed with the help of

natural sinks like oceans and natural vegetation on land is known as indirect carbon sequestration. (Farrelly et al, 2013).

Organizations set up environmental performance indicators in order to evaluate performance which helps them to monitor the sustainability within the organizations. To set the performance indicators, organizations use either standards recognized globally or by benchmarking the industry best solutions. These indicators will help to measure energy consumption, energy emissions, share of sustainable equipment etc. (Canfora et al, 2020). Based on this data, an analysis will be helpful for organizations to mitigate the environmental impacts by drawing up an action plan. Table 4.1 summarizes the critical climate risks within the operations of the N&T industry.

Table 4-1 Climate impacts risks and mitigation in operations

Climate	Risks	Mitigation of Risks	Source
Operations	Telecommunications contributes to a high amount of GHG gases and emissions	Smart equipment for saving power and reducing emissions	Singh et al, 2012
	Depletion of fossil fuels for energy generation	Use of Renewable energy	Canfora et al., (2020)
	Harmful gases are released by the coolants used in air conditioning of the energy consuming devices	Locating energy consuming devices/air conditioning equipment in open atmosphere for natural cooling	Singh et al, 2012
	Emissions while generation of energy to power up the network equipment	Use of Renewable Energy	Canfora et al., (2020)
	Energy wastage in the transmission through air	Bringing the transmitting and receiving antennas closer together (e.g., small cells, multi-hop wireless, etc.).	Matthews et al, 2010
	Large consumption of space and energy by base stations	Use of Software based flexi base stations	Singh et al, 2012

4.3.2 Climate Impact Within Telecommunications Supply Chain

To produce goods, various processes are involved such as sourcing of raw material, outsourcing the manufacturing processes, equipment assembly etc. The material and services are dispersed across the globe. Due to such dispersed processes and with the different stages of goods production, different environmental and social risks come into light. The focal companies are held responsible for the potential environmental and social hazards in the supply chain (Seuring & Müller, 2008). The management of the different business processes to avoid and improve the risks associated with the supply chain to achieve better short term and long-term performance in economic, social, and environmental goals is known as sustainable supply chain (Nalluri et al., 2021). Due to high competition, technological advances and uncertainty of demand, there are rapid changes within the telecommunications industries. (Nalluri et al, 2021).

According to Song et al. (2017), the major risk factors within the supply chain of telecommunications are selecting the right supplier, production and transportation of the equipment necessary for network, and the uncertainty in supply and demand. As an example, the emissions associated with the materials and the production process of base stations contribute to the largest share of their carbon footprint, also referred to as "embodied emissions". It is found that there are different types of risks and risk factors in different stages of the telecommunications industry and its analysis should be carried out to achieve sustainability within the supply chain of ICT sector (Madon, 2021).

To optimize the energy usage of the N&T sector, procurement of sustainable ICT equipment is considered to be the first step according to Canfora et al., (2020) as an environmental sustainability strategy. The most direct way to curb the environmental pollution within supply chain is to procure energy efficient devices, (EU GPP Criteria, 2012), for example procurement of devices that are eco-labelled. Eco-labelled products also help in reducing the indirect energy consumption by lowering the air conditioning requirements and hence lower energy associated with it (Canfora et al., 2020). In this regard, Valinejad and Rahmani (2018) highlight that the quality of the network equipment sourced contributes largely to the sustainability risks and thus, it needs to be taken into consideration. In connection with the network equipment quality, Sfez (2021) suggests that the telecom operators must ensure to consider energy consumption as one of the criteria to be used while making supplier selection decisions.

In order to make the supply chain sustainable, the buying companies must collaborate with responsible suppliers. (Badri et al. 2017). Responsible suppliers can be described as the suppliers who procure material in an energy efficient manner and integrate sustainability criteria within their own operations. During the assessment process, ensuring requirements such as certified environmental management system towards the N&T equipment manufacturers is a way of integrating sustainability standards in the procurement process. These environmental requirements towards the equipment manufacturers can help to prohibit the usage of non-toxic and non-hazardous materials in their products and production operations. Incorporating the sustainability requirements in the tenders and contracts during the supplier

selection process is critical (Canfora et al., 2020). Table 4.2 summarizes the critical climate risks within the supply chain of the N&T industry.

Table 4-2 Climate impact risk and mitigation in supply chain

Climate	Risks	Mitigation of Risks	Source
Supply Chain	Embedded emissions in the manufacturing processes	Use of eco-labelled products	Canfora et al., (2020); Sutherland, (2009)
	Operations of the suppliers	Compliance and regulations towards suppliers for responsible sourcing,	Canfora et al., (2020)

4.3.3 Social Sustainability Risks

The telecommunication industry involves transmission of electromagnetic field (EMF) radiations in-order to facilitate communications, however, there have been several health risks associated with these radiations (Valinejad & Rahmani, 2018). According to this research conducted by Valinejad and Rahmani (2018), the electromagnetic waves emitted by the telecommunication towers and other instrumentation equipment located in residential areas interfere with the human body and can cause damage to human immune and nervous system. Thus, it is important for the telecommunication operators to assess the network sites and make sure that they are EMF compliant, and safe for human exposure (Canfora et al, 2020).

Apart from these health hazards associated with the EMF radiations in the telecommunication industry, there are other health hazards such as noise pollution, air pollution and contaminated ground water due to the diesel and petroleum products used for operating base stations, especially in countries with weaker environmental regulations (Ojo, 2020). To mitigate these risks Ojo (2020) suggests that it is important to conduct cross-disciplinary research and design in conjunction with scientists and NGO´s.

There are social sustainability risks involved in the N&T supply chain as well. According to Valinejad and Rahmani (2018), the major source of supply chain sustainability risks originates from suppliers, who account for approximately 53% of these supply chain critical risks. Major concerns with respect to supply chain sustainability risks within the telecommunications industries are equipment quality, infrastructure capability and working conditions of employees (social sustainability). 87% of these critical risks account to external actors outside the focal companies' boundaries (Valinejad & Rahmani, 2018). According to Welbeck et al. (2020), the N&T sector has the largest share of the labor force (36.9%). In the multiple-tier supply chain of the telecommunication industry, safety environment of workers and laborers is a big concern in the upstream chain and thus aspects regarding work safety and

labor health needs to be considered in the supplier selection decisions (Badri et al., 2016). Chen et al. (2021) in their study on critical sustainability risks within the Indian telecommunication industry found unhealthy working conditions and use of hazardous materials that threaten the human health in the supply chain as one of the critical risks. Further, people who mount masts and are involved in the construction and maintenance activities of the telecommunication infrastructure are prone to unsafe work conditions (Welbeck et al., 2020).

Coltan (columbite-tantalite) is a rare earth mineral used to extract niobium and tantalum. (Genesis, 2015). Due to the material properties of tantalum (heavy, shiny, gray, soft when pure and hard when ductile), it is an important material used in the manufacturing of capacitors and high-power resistors. It can store energy due to its high volumetric efficiency. These capacitors and power resistors are one of the important components within the production of base stations and other N&T equipment. (Chemicool, 2015). Coltan is discovered in the mines of eastern Democratic Republic of Congo and hence DRC controls the taxation of the mining activities in that region. However, DRC is linked with militias and renegade units of the army. The militants are in-charge of the mining activities and carry out mining in an artisanal fashion (Sutherland, 2016). The mining activities in this region involves exploitation of human labor, sexual harassment, child labor, environmental damage, financing the armed groups. (Silva & Schaltegger, 2019). The sale of minerals from such conflict prone areas which involves financing of armed groups, and the associated social and human rights issues are known as conflict minerals (Silva & Schaltegger, 2019). Coltan (tantalum), tin, tungsten and gold are collectively known as 3TG which are some of the important materials required in the electronics industry. (Young, 2015).

The supply chain of the electronics industry is very complex and diverse with multi-tiered suppliers and multiple production processes. The production phase of some of the components involves mining extraction, trading, smelting, refining, transportation etc., and these phases impose several issues within environmental and social sustainability (Fourtuny, 2017). Due to this reason, there is a need for legislation to ensure that organizations do not support activities which pose risks to the environment or humans and conduct their business in a responsible manner. The focal organization should exclude the procurement of conflict minerals from DRC region and should not support the unsustainable activities in direct or indirect form. This includes taking relevant measures in the form of written rules within their code of conduct and other criteria to monitor and audit the exclusion of conflict minerals in their supply chain. To ensure compliance other strategies devised are substitution of the use of conflict minerals, responsible end of life management for an equipment by considering the circularity approach and communication in the form of certifications. (Silva & Schaltegger, 2019) Table 4.3 summarizes the critical social sustainability risks within the operations and the supply chain of the N&T industry.

Table 4-3 Critical social sustainability risks within the N&T sector

Category	Risk	Mitigation	Source
Social Sustainability (Operations)	Health risks associated with electromagnetic field (EMF) radiation	EMF Compliant	Valinejad and Rahmani, (2018)
	Health hazards due to air pollution, noise pollution and contaminated ground water because of telecommunications operations	More stringent environmental policies and conducting research to mitigate these risks	Ojo (2020)
Social Sustainability (Supply Chain)	Working condition of the employees, work safety and labor health risks in the multiple tier supply chain	Risks associated to working conditions and human health need to be considered during the supplier selection process	Valinejad and Rahmani, (2018); Ahmadi et al. (2016)
	Use of hazardous materials that threatens human health	Considering these risks during the supplier selection process	Chen et al. (2021)
	Unsafe work conditions particularly with respect to the external contractors involved in the construction and maintenance activities of the network and telecommunication infrastructure	Evaluating the external contractors for performance through metrics such as number of incidents and their mitigation actions.	Welbeck et al. (2020)
	Various social sustainability risks associated with the sourcing of conflict minerals	Stringent legislation policies, Responsible sourcing through code of conduct and audits, Demanding conflict mineral free certifications	Sutherland (2016), Silva and Schaltegger (2019), Fourtuny (2017)

4.3.4 Circularity

According to an estimate by the United Nations, 40 million Tonnes of electronic waste is generated each year and almost up to 80% of this waste is directed to landfills (White, 2021). If these electronic and electrical equipment end up in landfills, White (2021) states that they could release toxic chemicals into air, water and land and cause severe damage to the planet and human health.

Canfora et al., (2020) highlights the importance of the use of an environmental management system (EMS) within the telecommunications and network industry. From the circularity perspective, the critical performance indicators of EMS are implementation of an asset management system, the share of operations that measures and monitors the waste generated from electrical and electronic equipment. Thus, through the effective implementation of an EMS, reduction in water usage, equipment service-life extension, reduction in waste generated and emissions associated with it are the potential benefits that could be achieved (Canfora et al, 2020). Other performance indicators that are stated by Canfora et al., (2020) to reduce the resource consumption are the amount of waste generated that is recovered for reuse, refurbish, and recycle and the amount of waste sent to landfills.

The environmental impacts associated with digital technology and the N&T industry in specific is on high radar of the legislation as well. According to the new French law, telecom operators are obliged to report metrics regarding their solutions for recycling and reuse (Pollet, 2021). Making use of sustainability criteria such as presence of the use of environmental management system by suppliers and their preparedness for end-of-life practices such as collaborating to recollect network equipment at the end stages for remanufacturing are critical in the supplier selection process (Badri Ahmadi et al., 2017). Further according to Valinejad and Rahmani (2018), the maintenance and construction activities of the telecom operators such as cutting of cables generate irreversible waste into the eco-system. To facilitate careful waste management, Canfora et al., (2020) recommends a waste hierarchy framework as shown in Figure 4.1, according to which reduction in generation of waste gets the top priority followed by re-use, recycle, recover and disposal.

The telecommunications network industry is infrastructure intensive and hence, infrastructure sharing amongst network operators and usage of existing infrastructure to build new network lines enables reduction in consumption of unnecessary resources (Canfora et al., 2020). Sfez (2021) emphasizes that qualifying and quantifying the solutions for reducing resource consumption after establishing a governance model and mapping the energy consumption is important for implementing a green IT and network program. Nosiri et al. (2015) in their research on network infrastructure sharing amongst the telecommunication operators have found that with the sharing of infrastructure, unnecessary duplication of resources is eliminated leading to reduced consumption. Infrastructure sharing is the sharing of varied types of network infrastructure at a particular site between two or more operators to reduce costs, improve service quality and rapid expansion of network along with reduced resource consumption. Thus, infrastructure sharing creates a positive impact on both environmental and economic sustainability (Nosiri et al., 2015).

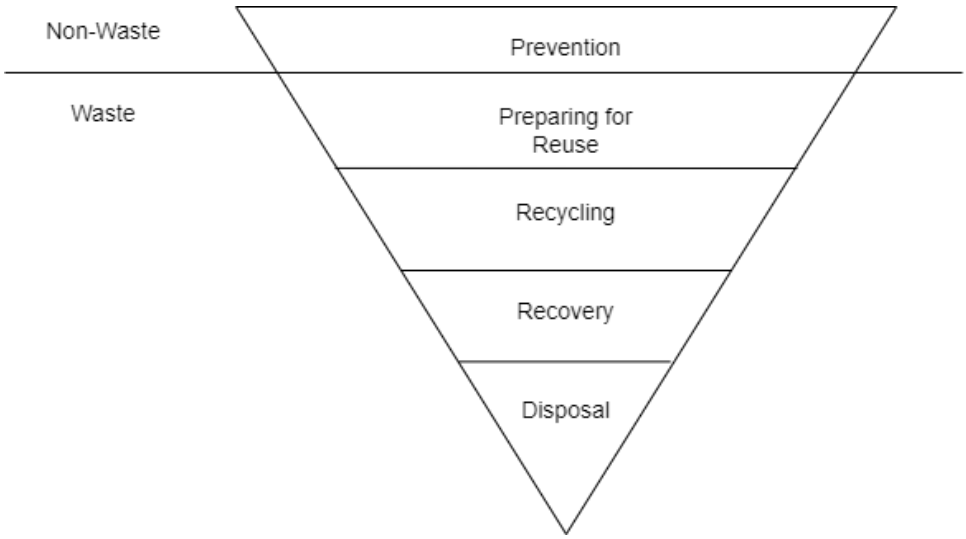

Figure 4-3 Waste management hierarchy (adapted from Canfora et al., (2020))

Although sim card is a very small component of the telecommunication sector, the emissions associated with its manufacturing and transportation are significant. According to White (2021), adopting circular practices such as dematerializing of sims that involves replacing the physical sims with e-sims will completely avoid the use of plastics and prevents them ending up in landfills. Replacing the physical sim cards with e-sims eliminates the use of resources such as plastic raw materials for the physical sim cards and packaging for these cards and reduces the harmful waste generated (Giesecke + Devrient, n.d). However, there are certain drawbacks of e-sims such as the possibility of data being hacked through a technology called cloud hosting (RF Wireless World, n.d). Although the complete transition from physical sims to e-sims has a long way to go, Tele2 AB has launched sims cards with holders that are half size of the regular ones to maximize resource utilization and minimize waste. This initiative by Tele2 AB has helped them to reduce about 6 tonnes of plastic and 35 tonnes of carbon emissions (Tele2 AB, 2021).

Chen et al. (2021) emphasizes that the right supplier selection is one of the major factors affecting the sustainability in the telecommunication supply chain. Badri et al., (2017) in their research on developing a framework for sustainable supplier selection in the telecommunication industry, identified one of the sustainability criteria for evaluating suppliers as "eco-design". Collaborating with the network equipment suppliers facilitates the inclusion of environmental sustainability in the design stage to extend the service life cycle of the equipment and to design products that are easy to disassemble and repair.

Madon (2021) studied the radio base stations that are the most energy intensive and critical nodes in mobile telephony communication. The outcomes of his research states that 91% of the emissions associated to these base stations are embodied emissions, out of which 41% of the emissions account to extraction of raw materials and its transformation. Thus, pressurizing the suppliers to reduce the usage of hazardous chemicals and raw materials for the manufacturing of the equipment is critical, that

ultimately reduces the waste from these electrical and electronic equipment (Canfora et al., 2020). Apart from reducing the waste and use of hazardous materials in the network equipment, Rezghdeh and Shokouhyar (2020) states that collaborating with the network equipment suppliers is critical towards the end-of-pipe practices such as reuse and recycling. This is supported by Badri et al., (2016) as they emphasize on eco-design in supplier selection process to reduce the involvement of hazardous materials in network equipment and reduce the waste generated in operations by collaborating with suppliers during the product development stage.

The software systems developed to run the telecommunication network functions contribute significantly towards the reduction of resource usage. By considering energy consumption during the development of these software systems, telecommunication operators can lower the amount of hardware equipment required and thus enabling efficient usage of resources (Canfora et al., 2020). All the discussed circularity risks are summarized in Table 4.4.

Table 4-4 Critical circularity risks within the N&T sector

Circularity	**Risks and Mitigation**	**Source**
	Release of toxic chemicals to air, water, and land because of the electronic waste directed to landfills, ultimately causing severe damage to planet and human health	White (2021)
	Lack of management systems and processes causes large amounts of waste generation and emissions associated to the waste generated.	Canfora et al., (2020)
	Lack of preparedness by suppliers for collaboration regarding end-of-life strategies of network equipment	Badri Ahmadi et al. (2017)
	Large amount of waste generation particularly because of the construction and maintenance activities such as cutting of cables	Valinejad and Rahmani, (2018)
	Lack of network infrastructure sharing and usage of virgin materials for every network expansion project	Canfora et al., (2020); Nosiri et al. (2015)
	Lack of metrics to qualify and quantify the solutions for reduction of resource consumption	Sfez (2021)
	Emissions associated to manufacturing, logistics and generated waste because of the physical sim cards and its packaging	White (2021); Sustainable eSIMs, (n.d.)

	Waste and emissions associated to product packaging and lack of supplier evaluation criteria such as the amount of recyclable material in the packaging	Valinejad and Rahmani, (2018); Canfora et al., (2020)
	Lack of collaboration with suppliers, especially in the design stage of the network equipment to promote eco-design and effective end-of-life practices such as reuse and recycling	Badri Ahmadi et al. (2017); Rezghdeh and Shokouhyar (2020)
	Extensive usage of hazardous chemical and raw materials in the manufacturing of radio base stations of mobile telephony causing high embodied emissions and waste at their end-of-life stage	Madon (2021); Canfora et al., (2020)
	Lack of consideration given to aspects such as energy consumption during the development of software systems required to run the telecommunication network functions	Canfora et al., (2020)

5 Volvo Group´s Responsible Sourcing

In this section, findings on the processes and initiatives taken up by Volvo Group towards sustainable sourcing are presented. The section is structured firstly by presenting the various tools and approaches implemented by the purchasing function in Volvo Group. Then, the usage of these tools and approaches for sustainable sourcing of indirect products and services are described. The section ends with a description of the supplier governance model within the N&T services sourcing. The findings described in this section are based on the internal interviews and the internal documents

5.1 Overall Strategy

Supplier code of conduct, CSR audits, self-assessment questionnaires (SAQ), hazardous chemicals reporting are the approaches used by Volvo Group in their efforts towards responsible sourcing. This section describes the key findings of these approaches.

5.1.1 Supplier Code of Conduct

Being an international organization, Volvo Group works with very diverse and international suppliers with different ethical backgrounds. However, in order to ensure that all the suppliers follow the same basic values in a responsible manner, the supply partner code of conduct is devised by Volvo Group. This enables the organization to rightfully select a supplier and guarantee that the suppliers practice their operations in a responsible manner. Through the supplier code of conduct Volvo Group aspires that their business partners also work with the same responsibility and goals. The supplier code of conduct sets requirements towards the supply partners in the area of “People”, “Resources”, “Climate” and “Business ethics”. The supplier code of conduct is based on the Volvo Group Sustainability Ambitions, Volvo Group Code of Conduct and their Group Policies. It is also governed with the Automotive Industry Guiding Principles of Drive Sustainability, frameworks of the UN Global Compact, OECD Guidelines for Multinational Enterprises, the UN Guiding Principles of Business and Human Rights, the UN International Bill of Human Rights, the International Labour Organization's (ILO), Fundamental Conventions and the UN Children’s Rights and Business Principles. The supplier code of conduct is meant to be followed by everyone who provides their goods or services to Volvo Group, which includes all the employees and their direct suppliers.

Suppliers to Volvo Group are expected to have policies which are in accordance with all the internationally recognized human rights and be compliant with them. This will help to prevent Modern Slavery and Forced Labour throughout their supply chain. Suppliers should have due diligence processes which include the Convention on the Rights of the Child to protect the children’s rights. Suppliers are encouraged to comply with ILO standards regarding working hours and prevent accidents and strain on employees. Suppliers are encouraged to promote diversity and inclusion and provide fair and equitable pay.

Volvo Group puts requirements within their supplier code of conduct towards sustainable sourcing of materials without adversely impacting the climate and human rights. Suppliers are encouraged to practice circular business models to improve environmental resource management and materials efficiency. Suppliers are expected to have a waste management strategy with the order of 8R framework of circularity. It is expected of the suppliers to adhere to the precautionary principles while using materials causing environmental and health risks. Suppliers are required to act in accordance with OECD Due Diligence Guidelines for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas. A CMRT (Conflict Mineral Reporting Template) report should be submitted by the suppliers on Volvo Groups request. Policies should be implemented to ensure the products containing minerals of concern should not directly or indirectly benefit the armed groups or abuse human rights. Zero procurement of materials is expected that contribute to illegal deforestation or sourced from deep seabed or sourced without respecting Indigenous people or originating from endangered species. Suppliers should implement a water management strategy to improve water use efficiency and protect water as a resource.

To reach the goal of UNFCC Paris Agreement, Volvo Group expects its suppliers to act in a responsible manner by reducing their environmental footprint within their operations and supply chain. Volvo encourages its suppliers to set science-based targets for their entire supply chain and scope 1, 2 and 3 as defined by the Greenhouse Gas Protocol Corporate Standard. The suppliers are required to monitor, track and document their emissions reduction plan. Use of renewable energy within operations and logistics and excluding the use of fossil fuels.

Suppliers are required to act with high standards of integrity within their operations and business relationship. Suppliers should not offer improper benefits to Volvo Group employees directly or indirectly to retain the business. Suppliers are encouraged to implement an information management strategy based on fair competition, cybersecurity, and anti-corruption. Table 5.1 summarizes the findings from the supplier code of conduct (Volvo Group, 2022).

Table 5-1 Key findings from supplier code of conduct

	Key Focus Areas
People	Modern slavery, children's rights, working hours and leave, wages and benefits, non-discrimination and fair treatment, freedom of association, health safety and well-being
Resources	Responsible sourcing of minerals and materials, Circular economy and waste management, Water management, Substances of concern
Climate	Net zero supply chain, Energy consumption
Business ethics	Business integrity, Fair competition, Data privacy, Information security

5.1.2 CSR Audits

Engaging with suppliers by performing onsite CSR audits has been one of several approaches to ensure sustainable sourcing by Volvo Group with a dedicated audit team. A CSR audit is a social audit conducted at the supplier´s site investigating the working conditions of their employees and workers. The CSR audit involves visual inspection and reviewing the policies and procedural documents of the suppliers to identify the non-compliance issues and the maturity level of the suppliers' practices (Volvo Group, 2021c). The CSR audits assess the gap between the supplier´s as-is situation to that of Volvo Group´s sustainability requirements and based on this assessment, the maturity level of the suppliers is determined for the purpose of evaluation. This helps Volvo Group to identify the sustainability risks within their supply chain and then based on these risks, corrective action plans are noted along with regular follow-up with the suppliers to assess the progress in the required areas (Dirk, personal communication 17th February, 2022). Thus, for Volvo Group, it is not just limited to compliance but also, it´s about impact, continuous improvement, and sustainable change (Volvo Group, 2021c). Performing these onsite CSR audits is mandatory for the high and extreme risks countries identified by Volvo Group before taking a sourcing decision by the top management (Dirk, personal communication, 17th February 2022). The five major focus areas of the CSR audits are summarized in Table 5.2, the risks in each of these areas are assessed and rated as "None, Low, High and Critical". Further, identification of any high or critical risk results in non-approval of the supplier (Volvo Group, 2021c).

Table 5-2 Five focus areas of CSR audits

Focus Area	**Description**
Management Commitment	In this focus area, the CSR audits aim to assess the commitment by the management teams of the suppliers, which involves investigating their way of working and managing their operations.
Health and Safety	Here, as the name suggests, the work safety issues of the suppliers' employees are assessed.
Environment	This involves assessing the impact of the suppliers' operations such as handling of hazardous chemicals and waste, and the quality of the air and water around the suppliers' site.
Business Ethics and Human Rights	The target of this focus area is to investigate the presence of issues associated with forced and child labor, employee wages and the business ethics followed by the suppliers.

Supply Chain Management	Investigating the sustainability risks is not just limited to the supplier´s operations, but also on how Volvo Group´s tier-1 suppliers handle their supply chain.

5.1.3 Self-Assessment Questionnaire

Self-Assessment Questionnaire (SAQ) is a questionnaire sent out to suppliers to assess their performance within sustainability. This questionnaire is developed by "Drive Sustainability", a partnership organization between the top original equipment manufacturers (OEMs) within the automotive industry and is facilitated by CSR Europe. This SAQ was developed in order to ensure sustainable sourcing and to have an industry-wide standard to assess the supplier´s performance, as it is tedious to the suppliers when different OEMs place varied demands (Volvo Group, 2021d). Volvo Group has partnered with an organization called 'NQC' to request the SAQ to all the suppliers and analyze their responses. NQC provides technical platform for sustainability assessments in the automotive industry and is a chosen supplier by Drive sustainability and other companies in the automotive industry. The advantage of using the NQC platform is several automotive companies including Volvo Group that are part of Drive Sustainability are utilizing NQC to get the opportunity to share the results of SAQs with each other, (Volvo Group, 2021d).

Apart from ensuring the supplier´s compliance to the code of conduct and onsite CSR audits, SAQ is one of the key approaches for sustainable sourcing by Volvo Group. Volvo Group provides regular training and e-learning opportunities to their suppliers with the objective of introducing the suppliers to Drive Sustainability and its ambitions, long-term activities, and commonly used tools such as the SAQ (Volvo Group, 2021d). It is mandatory for all the suppliers who are participating in Volvo Group´s sourcing projects to respond to the SAQ and the responses are valid for three years. Once the suppliers send back their replies to the SAQ along with the relevant documents, the suppliers are awarded a score based on their responses. If this score is above 60% that results in approval of the supplier or else, the supplier is not approved (Volvo Group, 2021d).

There are certain risks categorized as stopping parameters by Volvo Group within the SAQ such as lack of policies for child labor and young workers, forced labor, health and safety, environment and lastly, lack of sustainability requirements towards their own suppliers. If any of these stopping parameters are observed, then that leads to the supplier being non-approved irrespective of their score in the SAQ (Volvo Group, 2021d). It is to be noted that the non-approved suppliers are allowed to participate in the sourcing process, only when they provide an approved action plan, and this plan needs to be followed-up by the respective buyers (Dirk, personal communication 17th February 2022).

The SAQ focuses on the following major areas Company Management, Working Conditions and Human Rights, Health and Safety, Business Ethics, Environment, Supply Chain Management, and Responsible Sourcing of Raw Materials (Volvo Group, 2021d). Assessing the company management

involves investigating their sustainability organization and its management and assessing supplier´s internal documents such as their code of conduct, environmental policies, employee benefit policies etc. The environment focus area of the SAQ investigates the suppliers' commitment to reduce their carbon footprint and investigates the usage of management systems related to environment, energy usage, international material data systems to achieve their commitments. Lastly, the initiatives within the responsible raw material sourcing focus area perform a due diligence check with respect to sourcing, extraction and handling of minerals closely associated to human rights violation (Volvo Group, 2021d).

5.1.4 Substances of Concern

According to a new EU legislation, companies providing products or articles that contain substances of very high concern (SVHC) above a concentration of 0.1% weight/weight on the EU market needs to provide information on these articles to European Chemical Agency (ECHA). These companies provide the data on such articles or products through the SCIP database, which is the EU database for information on "Substances of concern in articles as such or in complex objects (products)" and was developed under the waste framework directive (WFD). The purpose of this legislation is to ensure the availability of information about the presence of the SVHCs throughout the whole lifecycle of products and materials including the waste stage (Volvo Group, 2021e). SVHC is a chemical substance that is carcinogenic, mutagenic, Toxic for reproduction, and persistent (not easily biodegradable) and these substances are listed in "Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH)".

Further, the automotive suppliers are obliged to provide a material data sheet to the International Material Data System (IMDS), and it needs to include the component structure, material and substance composition. IMDS is the material data system for the automotive industry and the purpose of it is to increase the transparency of chemicals and materials in products (Volvo Group, 2021e). Apart from IMDS and SCIP reporting, there are other regulatory directives regarding the substances of concern such as the REACH directive. REACH compliance assessment is part of Volvo Group´s sourcing process and it confirms to fulfil the obligations under the REACH regulation to document registration of parts with mixture of substances, such as (but not limited to) detergents, alloys or paints or articles releasing substances (Volvo Group, 2021e).

5.2 Volvo Group´s Approach to Sustainable Indirect Procurement

The self-assessment questionnaire and the onsite CSR audits discussed earlier are applicable to Volvo Group´s indirect procurement as well. Transportation and logistics accounts for major climate impacts with regards to Volvo Group´s direct procurement. An important strategic approach to mitigate the negative impacts of logistics on climate is to source more locally in all possible sourcing projects (B. Gajendra, personal communication, February 16, 2022). However, in indirect procurement of products and services, most of the sustainability risks originate from a further upper stream of suppliers and thus,

it is critical to design the sustainability evaluation criteria accordingly (B. Eva, personal communication, January 19, 2022).

Although Volvo Group makes use of SAQs and audits in sourcing indirect products and services, they note that most of the evaluation criteria present in these two approaches are either general or specific to direct procurement involving automotive suppliers. Thus, Volvo Group believes that it is important to evaluate the sustainability performance of suppliers involved in indirect sourcing projects in a more concrete way by developing a sustainability questionnaire that would be put forth in the request for proposal. This approach is supported by Volvo Group´s top management, who demand and encourage the buyers to evaluate the suppliers based on their sustainability performance before presenting a sourcing project to them for a decision. As an example, in one of the indirect sourcing projects of datacenter services, Volvo Group requested the suppliers to respond to several sustainability questions as part of the RFP. Then, the supplier responses to these questions were subjectively evaluated and considered along with other business requirements to make select a supplier. The questions asked in the RFP of this project were general like assessing the supplier´s climate impacts, sustainability initiatives and their roadmap for improvement. But Volvo Group aims to develop these questions and make it more concrete, specific and mature in the future.

5.3 Supplier Governance Model within Network and Telecommunication Sourcing

After awarding a contract to a supplier, it is important for Volvo Group to have a follow-up on the supplier´s performance throughout the contract lifecycle. This supplier governance is a part of contract and vendor management within Volvo Group. Supplier governance was outsourced to a third-party business partner several years back. However, since a couple of years, Volvo Group has resourced its contract and vendor management activities at the tactical and strategic level including the supplier governance due to the increasing risks in the supply chain (Volvo Group, 2020).

Volvo Group´s present supplier governance model presented in Figure 5.1 has three levels of contact points with the suppliers for following-up on various issues. The first level is the operational level that involves follow-up on the quality of the service on a day-to-day basis throughout the contract lifecycle and this level of follow-up has been contracted to a third-party business partner.

The second level of follow-up is the tactical level involving evaluation of the sourced service and discussions on potential improvements by aligning each other´s business goals and the frequency of tactical level of governance is monthly. The evaluation of the sourced service occurs through a supplier rating model developed by the sourcing team. This model has various parameters on service quality and payment processes which are subjectively evaluated on a scale of 0 to 9 and bad scoring on any of these parameters are taken up as priority actions to improve the scores. Further, discussions on improvements at the tactical level involve innovation and development projects, financial review and regular contract and purchasing management.

Lastly, the third level of follow-up is strategic governance in which the top executive management from both Volvo Group and suppliers meet to discuss aspects such as the supplier relationship ambitions and business goal alignment. Volvo Group is responsible for the tactical and strategic level of supplier governance. The necessity and the frequency of supplier governance meetings depends on various aspects such as the purchase volume and service variability. To facilitate the achievement of strategic sustainability goals, Volvo Group aims to include discussions on various sustainability topics at the tactical and strategic level governance as a measure to ensure responsible sourcing, (Interaction, Guillaume)

Figure 5-1 Volvo Group Supplier Governance Model

6 Findings and Results

In the following section, we introduce the findings from interactions with three major suppliers within the network and telecommunication industry. These three suppliers are AT&T, Tele2 and Telia. AT&T has most of their operations in the region of the United States of America (USA) while, Tele2 and Telia have most of their operations in the Scandinavian countries. In this section, the corporate sustainability reports, and data from websites and interviews of these three suppliers are described and based on these descriptions the sustainability risks within their operations and supply chain are described. Further, how these suppliers handle and mitigate these sustainability risks are noted as well.

6.1 Tele2

This section comprises of how Tele2 handles the sustainability risks observed by them. The structure of this section is categorized as operations, supply chain and circularity based on where the risks are present. The information for this section has been obtained from interviews with the stakeholders at Tele2, their CSR reports and e-mail follow-ups.

6.1.1 Operations

A set of ambitious goals to reduce GHG emissions has been set and approved by the science-based target initiative (SBTi). The goals are measurable which helps the organization to stay focused and maximize the value offering. In order to fight climate change Tele2 has set goals within its sustainability strategy to boost the innovation within their technology, operations. To create sustainability value, Tele2 has integrated the sustainability goals as a part of their daily business and operations. Tele2 also works in alignment with the United Nations Sustainable Development Goals (UN SDG) (Tele2, 2022). Tele2 is 100% climate neutral in case of their operations within the scope 1 and scope 2 emissions. Also, they have achieved a 90% reduction in their GHG emissions in scope 1 and scope 2. Most of the scope 2 emissions are reduced because of Tele2´s 100% renewable electricity sourcing and additionally, they provide guarantee of origin certificates assuring the legitimacy of the source. The rest of the emissions are offset using carbon removers and hence carbon offsetting is carried out (Tele2, 2022) e.g., by investment in renewable energy projects. Followed by this, carbon removal projects are undertaken with the aim of 100% removal and binding of carbon. Also projects to prevent deforestation are undertaken and carbon credits have been purchased in Iceland (Wottrich. E., personal communication, April 11, 2022).

Tele2 conducts several research projects, in order to take a lead in sustainability and to contribute knowledge with respect to these topics. For example, the ongoing project called ‘AI4green’ aiming towards energy efficiency of mobile networks with 15 different partners from 5 different countries along with universities as contributors. These projects aim to improve the architecture and support the development towards energy efficiency. Another such project is ‘SooGreen’ which is about energy efficiency within mobile networks. The findings from this research project have been implemented in the operation of mobile networks. One of the findings was on energy reduction in mobile networks by

switching off the energy consuming devices when not in use for milliseconds without hampering the quality-of-service output (Wottrich. E., personal communication, April 11, 2022). For instance, the new base stations which rolled out in 2021 has made significant reduction in energy usage. The new base stations have power saving mode features such that the power amplifier within the base station is put on standby in case of no data transfer. Tele2 makes sure that these investments made within their operations provides them return and maximize the value for the society (Tele2, 2022). Other than this, towards energy efficiency Tele2 is undergoing the rollout of 5G networks and also network modernization by incorporating energy saving smart equipment (Tele2, 2022). Furthermore, Tele2 is working with virtualization of its network operations, it is estimated to provide 10 times more efficiency within the operations (Wottrich E., personal communication, April 27, 2022)

The employees and workers working on behalf of Tele2 are covered with the Occupational Health and Safety Management System. A code of conduct based on the United Nations Global Compact is applicable for all the employees. This way Tele2 avoids contributing to any sort of negative human rights impact. In case of the ICT sector, a lot of emissions in the form of electromagnetic radiation are observed. Tele2 follows the norms by the World Health Organization, following the International Commission on Non-Ionizing Radiation Protection's guideline (Tele2, 2022).

The maintenance workers at tele2 are covered with the safety and health policies which are in accordance with Swedish work-related injuries and labour regulations. Tele2 follows all the directives with respect to construction as mentioned by the Swedish legislation, this involves doing an environmental assessment for wetlands and waterbeds, biodiversity, risk assessment towards humans, etc. Tele2 also conducts on site audits on the construction suppliers. (Wottrich E., personal communication, April 27, 2022)

Within the operations related to handling of devices and electronic equipment with respect to the hazardous chemicals, Tele2 follows ROHS directives. Further, with respect to handling of chemicals within electronic equipment, other directives such as ordinance on producer responsibility for electrical and electronic equipment, environmental impact assessment ordinance and the REACH regulation are followed. This REACH regulation provides a list of chemicals to be avoided or handled in a responsible manner. The climate risks identified within the N&T operations of Tele2 and their mitigation approaches are summarized in Table 6.1.

Table 6-1 Summary of N&T climate risks and mitigation within the operations of Tele2

Climate	Risks	Initiatives
Operations	ICT equipment have high energy consumption	Projects like AI for green to power off energy consuming devices when not in use
	Emissions which cannot be controlled or reduced	Carbon offsetting, use of carbon removers, investment in renewable energy projects for carbon neutrality, purchase of carbon credits
Social Sustainability	Emissions of radiations from network operations	Tele2 follows the norms by the World Health Organization, following the International Commission on Non-Ionizing Radiation Protection's guideline

6.1.2 Supply Chain

The purchased goods and services contribute the major amount of scope 3 emissions and thus, Tele2 aims towards achieving neutrality with respect to its value chain (scope 3). In an action plan to reduce these emissions, Tele2 communicates its sustainability targets to the top suppliers with respect to spend which involves the largest operation by percentage. Tele2 also encourages the suppliers to put forth the sustainability targets in their own operations (Tele2, 2022). The progress of the suppliers is monitored for the targets. For the supplier assessment, Tele2 uses the EcoVadis platform, which focuses on questionnaires related to environment, labor and human rights, ethics and sustainable procurement. Ecovadis platform has a predefined set of questions for all industries as well as industry specific questions (Wottrich E., personal communication, April 11, 2022).

Tele2 also conducts on-site audits based on the business partner's code of conduct to assess the sustainability performance of the supplier with respect to the risks associated with the supplier (Tele2, 2022). The code of conduct focuses on five areas, namely product safety, environment, human rights, ethics and procurement decisions. Within business ethics, questions are based on anti-corruption, fair competition, conflict of interest, financial reporting and corporate governance. The human rights within the code of conduct focuses on fair working conditions, specifically on child protection, diversity and inclusion, compensation and benefits, and occupational health and safety. Within the environmental field, the focus is on environmental management and specifically on responsible and safe products. The decision to conduct an audit is based on the geographical location of the supplier, the product being

sold, score from the ecovadis platform etc. The general types of risks which are repeatedly observed with the telecom suppliers are related to the emissions and the human rights issues (Wottrich. E., personal communication, April 11, 2022).

Tele2 does not collaborate with other third-party suppliers for its onsite audits. They believe since most of the top equipment providers are audited by these third party (like JAC) for which tele2 is also a customer, tele2 focuses on doing audits with their critical suppliers. However, in some cases tele2 works with consultants which are located overseas for their overseas suppliers, this avoids the international travel for tele2 for instance during the pandemic era.

As a telco, Tele2 does not produce any product containing conflict material. However, there is a use of such material within the hardware and equipment. As a responsible organization Tele2 has directives and policies which make the suppliers abide by the regulations of handling such materials. They have incorporated the conflict mineral policies within the business code of conduct and environmental policy, which are signed by the suppliers handling these materials. This makes the suppliers have a policy at their end within their operations to handle the conflict materials responsibly (Wottrich. E., personal communication, April 11, 2022). The climate risks identified within Tele2's N&T supply chain and their mitigation approaches are summarized in Table 6.2.

Table 6-2 Summary of N&T climate risks and mitigation within the supply chain of Tele2

Climate	Risks	Initiatives
Supply Chain	Devices containing hazardous chemicals	ROHS directive, procurement of CE marking goods, asking the suppliers to be compliant with directives such as ordinance on producer responsibility, environmental impact assessment ordinance and the REACH regulation.
	Operations of suppliers	Compliance of suppliers according to the business code of conduct which focuses on Labour and human rights, environment, sustainable procurement, product safety
	Conflict material containing devices	directives and policies towards responsible sourcing
	Sustainability risks associated with critical suppliers	On-site Audits

6.1.3 Circularity

Throughout the value chain of Tele2, they try to minimize the waste generated by being responsible and more sustainable within the usage of the natural resources. Apart from waste minimization, Tele2 is committed to achieving 100% circularity within its network equipment. The sustainability strategy of Tele2 focuses on the advancement of the circular economy in order to fight climatic changes (Tele2, 2022).

In order to facilitate efficient resource consumption within the value chain, Tele2 makes use of the following three approaches: pressurizing suppliers for efficient resource consumption, increased reuse of hardware and collecting and recycling e-waste from customers. Careful resource consumption is achieved by increasing resource efficiency by reusing, recycling, and refurbishing the old technology hardware. Tele2 has set targets for reuse and recycling of the equipment. The aim is to avoid the disposal of equipment, and to make use of it till end of life. The priority towards discarded equipment is as follows, it is recommended to reuse an equipment or else recycle it and dispose the equipment in a responsible manner as the last option. Also, with respect to reuse of equipment, Tele2 understands the fact that reusing equipment will help to obtain financial incentives along with environmental and social incentives. In the case of 5G implementation, an action plan has been set up to handle the network equipment in a more sustainable manner. Tele2 has also set goals to take care of establishing sustainable processes for handling and logistics of network equipment for the end-of-life strategies of these equipment.

Tele2 shares 50% of its 3G network infrastructure with Telia whereas in the case of 2G, 4G and 5G 50% of network infrastructure is shared with Telenor. This infrastructure sharing helps to cut down the carbon footprint by 50% and helps in cost savings. Network infrastructure sharing has shown zero issues within the quality of customer service (Wottrich E., personal communication 27th April).

In their efforts towards circularity, Tele2 during their rebranding phase seized an opportunity that enabled them to act in an environmentally friendly manner by reducing the size of the SIM cards. This was one of the projects that Tele2 initiated by collaborating with their suppliers. By reducing the sim cards size from the size of a credit card to half of it, Tele2 saved several Tonnes of plastic as waste. The circularity risks of Tele2 and their mitigation approaches are summarized in Table 6.3.

Table 6-3 Key findings regarding the sustainability risks within circularity and efforts by Tele2

Climate	Risks	Initiatives
Circularity	Damaged Equipment	Reuse, refurbish equipment, if reuse is not possible recycle in a responsible manner
	Old devices	Collecting devices from customers for recycling
	Energy Consuming devices	Modernization of network operations
	Resource Depletion	Use of small sized sima cards for material saving

6.2 Telia

In this section the authors discuss how Telia handles the sustainability risks observed within their operations, supply chain and their strategy towards waste management. The discussion is based on Telia's CSR reports, interviews conducted with their sustainability representatives and email follow-ups.

6.2.1 Operations

Telia, being a responsible telecommunication operator, takes full responsibility for their operations and the GHG emissions associated with it. Ambitious goals were set in the year of 2019 to battle the rising global warming impacts which are approved by the science based imitative. The focus is towards a road to zero emissions and offsetting remaining emissions which cannot be eliminated. The carbon offsets are in the form of industrial and biological removal credits which help to remove CO_2 from the atmosphere. For the industrial removers, Telia uses a material made of cellulose fiber that absorbs and stores carbon during production activities.

Telia´s approach towards managing their energy consumption includes energy efficiency projects through new network hardware and power consumption management through decommissioning of legacy hardware and modernizing sites (Telia, 2022). Network modernization is very critical as new network hardware equipment are more energy efficient per unit of data transferred than the legacy equipment. There are a lot of things that needs to be considered in upgrading and modernization of hardware in the network, there is a trade-off between getting rid of the old hardware to be more energy efficient and resource consumption with the circularity perspective. Thus, it can be concluded that, although the newer equipment is more energy efficient, getting rid of the old equipment must be taken care of in a sustainable way as well (Lindwall M., personal communication 6th April, 2022). Further, a project named "Daisy" was one of the Telia´s successful virtualization and consolidation projects

involving its global datacenter operations. As a result of this project, Telia was able to achieve higher efficiency, utilization rate and automation leading to cost reduction and more efficient energy management (Lindwall M., E-mail follow-up, 13th April, 2022).

Telia´s datacenters in the Nordics are an excellent example of their energy efficiency projects. They have developed a concept called "Green Room Concept" for these datacenters, where the heat dissipated from the servers and the IT equipment is reused for other purposes such as district heating and the cooling of the servers and IT equipment is performed in a smarter and an efficient manner. This way of operating and maintaining the datacenters, apart from contributing to the sustainability targets, reduces the operating costs as well (Telia, 2022).

With respect to HVAC telia works with green cooling solutions which produces lower CO2 emissions than usual. Cooling takes place by a combination of free cooling and geothermal energy. This helps to incur the cost benefits for the organization as well as contribute towards energy efficient operations within the industry (SEE cooling, n.d.).

These various energy savings projects are planned on a long-term basis and are expected to reap results over the years. Looking at the energy savings from a financial perspective, "With the energy prices going up, we have all reasons in the world to try to keep our energy consumption down. So, when these two meets, that's always good, because then you get the financial drive as well around it" (Lindwall M., personal communication 6th April, 2022). Further, Telia strives towards 100% renewable electricity in their operations and looks for other alternatives for the remaining fossil-based sources (Telia, 2022). The use of diesel as back-up power in their operations contributes most to their remaining emissions in the operations, (Telia, 2022) For instance, they are working with business partners to explore solutions on deploying used batteries as energy storage systems for back-up power (Lindwall M., personal communication 6th April, 2022).

To develop and improve sustainability within the telecommunications industry, Telia collaborates with organizations such as GSMA and ETNO. Telia along with other actors in the industry such as Ericsson were involved with GSMA in publishing various white paper reports on the climate and circularity initiatives and drafting the climate goals based on science-based targets for the telecommunication industry. Further, the activity in this collaboration includes exploring the various ways in which digital connectivity can contribute towards sustainable development in other industry sectors. Telia along with other European telecom operators launched an eco-rating to assess the environmental impact of the mobile phones over its entire life cycle. To scale this eco-rating initiative to other telecommunication operators, Telia´s collaboration with GSMA was critical. Apart from this work with GSMA, Telia collaborates with ETNO to review and work on policy development such as the EU green deal and legislation policies. Overall, these collaborations play a major role in technology development, new technologies and standardization in the telecommunication sector (Lindwall M., personal communication 6th April 2022). The climate risks identified within the N&T operations of Telia, and their mitigation approaches are summarized in Table 6.4.

Table 6-4 Summary of N&T climate risks and mitigation within the operations of Telia

	Risks	**Initiatives**
Operations	Lack of collaboration with other institutions and organizations might impede the pace of industry´s sustainability achievements	Telia along with other actors of the telecom industry collaborates with GSMA and ETNO to explore innovative sustainability solutions that benefits the whole telecommunication industry
	Effective energy management is crucial for both the company's growth and environmental sustainability	Telia´s approach towards managing their energy consumption includes energy efficiency projects through new network hardware and power consumption management through decommissioning of legacy hardware and modernizing sites
	The entire telecommunication operations are highly energy intensive and account to high scope 2 emissions from these telecommunication operators	Telia strives towards 100% renewable electricity in their operations and other alternatives for remaining fossil-based sources such as deploying used batteries as energy storage systems for back-up power
	Neglecting sustainability aspects in the design stage of a network equipment impacts the effective practice of end-of-life strategies	Telia provides training on subjects such as eco-design to its employees in functions such as product development and sourcing.

6.2.2 Supply Chain

In 2018, with the help of a business partner Telia assessed their supply chain emissions depending on the business or industry of the supplier and Telia´s spend on that supplier. The result of measuring the supply chain emissions showed that the top 100 suppliers contributed about 80% of the emissions (Lindwall M., E-mail communication 13th April 2022).

The contract agreements, providing training to employees on subjects such as eco-design and supplier code of conduct are a few major ways to ensure sustainable practices from the suppliers for Telia. Thus, Telia recently updated their code of conduct with major changes. One such change is mandating all the first-tier suppliers to track their carbon emissions and have a roadmap regarding the reduction of these

emissions over the years to achieve net-zero emissions and this roadmap with the targets must be verified by SBTi. To track the progress of the suppliers on the maturity level of their sustainability targets, Telia has developed an evaluation model that assesses the suppliers on a scale of 1 to 7. Thus, to monitor and reduce these supply chain emissions, Telia focuses on evaluating these top suppliers with the developed evaluation model (Lindwall M., personal communication 6th April 2022). Telia has understood that it is not sufficient to collaborate with a few global suppliers to achieve its sustainability targets. Thus, Telia has joined 1.5°C supply chain leaders' group to investigate the tools and practices necessary for collaborating with small and medium sized suppliers to reduce their carbon emissions (Telia, 2022)

The sustainability risks in the supply chain of Telia are as diverse as the supply chain itself due to the diverse risks associated to different types of businesses, products, and supplier locations (Lindwall M., personal communication 6th April, 2022). Telia's biggest concern is to mitigate the risks originating from labor rights violations including child and forced labor in their supply chain. To mitigate such risks, Telia categorizes these diverse risks and invests their efforts accordingly. These mitigation efforts include making sure that the code of conduct is aligned with multiple tiers in the supply chain including the third-party contractors, self-assessment surveys and audits in collaboration with external parties such as JAC. According to Telia, various certifications such as ISO are sufficient to mitigate the risks, but sometimes they believe it would be obvious to do an audit themselves (Lindwall M., personal communication 6th April 2022)

Apart from the human rights and work safety risks, risks related to conflict minerals plays a crucial part in mitigating social sustainability risks. Telia avoids the association with such suppliers which mine in an unstainable manner and aims at sourcing conflict free minerals. (Telia, n.d.). To mitigate this risk, Telia have included a much clearer demand over the use of conflict minerals within their code of conduct. The updated demands regarding the conflict minerals require Telia´s suppliers to procure tin, tantalum, tungsten, and gold only from responsible sources (Telia, 2017).

Telia has developed a list of black and grey items which is based on global legal requirements and national legal obligations and hence they avoid using it in their operations. Within the supplier code of conduct telia puts requirements towards their suppliers and supplier's supply chain to avoid the use of such items within the products associated with Telia. All the material procured is assessed with specific procedures with risk assessments. Telia practices being compliant with environmental legislation and with market requirements so as to avoid any harm to humans and the environment. Telia abides by the REACH (Regulation of the European Parliament and of the Council on the Registration, Evaluation, Authorization and Restriction of Chemicals) compliance (Telia, n.d.)

The major risks identified by Telia within the multiple tiers of their supply chain are the working and labor conditions and the environmental and social sustainability risks associated with mining of metals and materials required for the products that they source. For instance, during last year Telia suspected probable forced labor activities involving people from the Uighur minority of China within the

operations of their suppliers present in China. Telia has not observed or reported any sort of child labor risks within their supply chain, however they believe that it does not mean that they do not exist. Also, Telia believes that these risks are more prominent further up in the supply chain and in the case of supplier production locations far from the market they serve.

The contract agreements and supplier code of conduct are regularly amended along with regular follow-ups to mitigate the social sustainability risks by ensuring that the suppliers have policies in place to govern the risks and are implementing them on a full-scale. Apart from the code of conduct, Telia in-order to mitigate these risks, are in discussion with their suppliers exploring solutions such as reshoring of supplier´s production facilities nearer to Telia´s market. Also, to resolve the labor risks that were suspected last year within China, Telia is in constant dialogues with these suppliers along with JAC demanding more transparency to ensure that there is no forced labor practiced. However, there are various other aspects to be considered regarding reshoring such as the labor costs associated to production (Lindwall M., personal communication 6th April 2022)

External contractors providing services such as construction and maintenance of network infrastructure are part of a telecommunication operator´s supply chain. Telia like any other operator have identified various work safety related risks amongst the employees of these contractors working in the construction site (Lindwall M., personal communication 6th April 2022) The health and safety risks that are close to Telia´s operations include working at heights to perform network construction and maintenance activities which are carried out by third-party contractors (Telia, 2022). To mitigate these risks, Telia works with a document similar to a catalog that lists several work-related health and safety risks, and they discuss these risks in their meetings with external contractors regarding their ways of handling these risks. Further, these external contractors report a metric showing the number of such risk incidents that occur in each month to track the progress in mitigating these risks. Also, most of these risks need to be taken care of by these external contractors as a requirement of legislative laws as well (Lindwall M., personal communication 6th April 2022). The climate risks identified within the N&T supply chain of Telia, and their mitigation approaches are summarized in Table 6.5.

Table 6-5 Summary of N&T climate risks and mitigation within the supply chain of Telia

	Risks	**Initiatives**
Supply Chain	Telia has estimated that about 91% of their emissions are accounted for in their supply chain and hence, it is important to source responsibly.	Telia as a way of responsible sourcing ensures that their suppliers have set climate action goals and are verified by SBTis. Also based on the climate maturity of each supplier, Telia awards them a climate scorecard which is used in making sourcing decisions.

	It is not sufficient to collaborate with a few global suppliers to achieve the sustainability targets. Collaborating even with the small and medium scale suppliers is critical from the sustainability viewpoint	Telia has joined 1.5°C supply chain leaders' group to investigate the tools and practices necessary for collaborating with small and medium sized suppliers to reduce their carbon emissions.
	Use of conflict minerals is a risk within the supply chain of Telia	To mitigate this risk, Telia demands their suppliers to source conflict minerals only from responsible sources and this demand is an integral part of their supplier code of conduct
	Few of the major social risks in Telia´s supply chain are child and forced labor, working hours and health and safety risks. Telia is prone to these risks especially from third-party contractors responsible for construction and maintenance activities	Telia conducts onsite audits along with their csr audit partners JAC to mitigate risks associated to human rights and work-related health and safety in the lower tier suppliers

6.2.3 Circularity

One of the Telia´s targets aim is to reduce the waste in their operations to achieve zero waste by 2030. To operationalize the actions towards the zero-waste target, Telia makes use of the “Prevent – Reduce – Reuse – Recycle" along with exploring and expanding the circular business models in all their operations. Telia´s circularity initiatives are focused on increasing the share of materials reused and recycled from their own network operations, this work towards zero waste includes network maintenance and construction operations carried out by Telia´s contractors (Telia, 2022)

Circularity is increasingly becoming critical in the network and telecommunication operations owing to the large amount of network hardware involved. As of today, Telia reuses or recycles about 74% of its network hardware and the impregnated telephone poles that cannot be reused or recycled accounts to about 25% of the remaining share. Energy efficiency projects such as network modernization involve the need to decommission the old legacy equipment. This decommissioning of the old equipment to treat them in a responsible way involves transport and logistics that itself has certain carbon emissions. Also, for a large company such as Telia, there is a lot of legacy equipment that needs to be decommissioned due to various technical and historical reasons such as services offered to customers and the amount of time present in the industry. For instance, Telia´s operation in Sweden has around one and half million telephone poles that needs to be decommissioned by 2026. (Lindwall M., personal communication 6th April 2022).

Adding to all the other difficulties, decommissioning of telephone poles is even more critical as they are impregnated with carbonaceous chemicals such as creosote that are harmful to human health and thus cannot be reused and it needs to be incinerated in a Safe way. With respect to the decommissioning of legacy equipment, "we can't have a target saying we have no waste because we will have a lot of waste because we have things that we have to take care of", (Lindwall M., personal communication 6th April, 2022) There are a lot of things that needs to be considered in upgrading and modernization of hardware in the network, there is a trade-off between getting rid of the old hardware to be more energy efficient and resource consumption with the circularity perspective. Virtualization of network function is another energy efficiency method, which is a way to convert a hardware function into a software function in order to eliminate energy intense network equipment. Further, circularity issues regarding the eliminated equipment due to virtualization needs to be addressed. Telia considers the circularity hierarchy principles and thus, reuses or repurposes the eliminated equipment or even resells it to a secondary market and as a last option, Telia works with certified recycling vendors to generate revenue and close the resource loop through recycling (Lindwall M., personal communication, 6th April 2022)
Apart from the network hardware, there is a significant amount of waste generated because of the network construction, especially the rollout of fiber cables in the ground. Telia collaborates with Stena recycling, who is Telia´s main partner to collect obsolete network equipment and reuse or recycle the whole equipment or just its components. Although, the target is to have net-zero waste, there is still about 1% of waste being incinerated or sent to landfills. However, Telia is continuously exploring solutions with its external contractors to reuse the wastes produced such as soil and gravel due to incineration. To conclude, a key finding regarding the various circularity initiatives is that their viability is bound to a trade-off with the logistics costs (Lindwall M., personal communication 6th April 2022)
In-order to accelerate Telia´s circularity targets, Telia has considered to have stringent contract terms and amendments to its code of conduct regarding the circularity aspects within their operations. Telia believes pressurizing suppliers regarding such aspects is critical, especially the external contractors as they are responsible with all the network construction of Telia (Lindwall M., personal communication 6th April 2022). The circularity risks of Telia and their mitigation approaches are summarized in Table 6.6.

Table 6-6 Key findings regarding the sustainability risks and efforts by Telia on circularity

	Risks	**Initiatives**
Circularity	There is a large amount of electronic waste generated because of the network hardware. Construction and maintenance activities including the rollout of fiber	Telia collaborates with Stena recycling to collect obsolete network equipment and reuse or recycle the whole equipment or just its components. To handle waste management associated to construction and maintenance, Telia

	cables contribute to other waste	has developed stringent contract terms and amendments to its code of conduct to pressurize suppliers regarding waste management
	Decommissioning of telephony poles that are impregnated with carbonaceous chemicals such as creosote that are harmful to human health	These telephony poles cannot be reused and needs to be incinerated in safe way

6.3 AT&T

This section documents the sustainability initiatives by AT&T. The section is structured in the manner in which AT&T mitigates their sustainability risks within operation, supply chain and their waste management strategies. The findings are based on interviews conducted with the sustainability managers, the CSR reports and issue briefs mentioned on their website and email follow-ups.

6.3.1 Operations

As a first step AT&T identifies and measures the impact of climate related risks in their operations by their network infrastructure, products, and brand. The risks are assessed internally by risk management tools. AT&T is in a continuous process to explore mitigation strategies with respect to climate change. One of the most important goals of AT&T is to develop and deploy a roadmap to identify the impact of greenhouse gas emissions produced by AT&T on society (AT&T Issue Brief, Climate Change, n.d.). Towards the aim of lowering the carbon footprint, AT&T has joined the science-based targets initiative in 2021 to set ambitious goals for their operations and suppliers (AT&T Issue Brief, GHG emissions, n.d.).

To reduce the emissions associated to energy consumption, AT&T inculcates renewable energy in their operations. They have set the goals to become climate neutral within the scope 1 and scope 2 of their emissions by the year 2035. AT&T is one of the largest purchasers of solar energy in the world and they invest resources in increasing their onsite renewable energy production through installation of solar photovoltaic cells and fuel cells. AT&T is involved with several power purchase agreements with developers of renewable energy, this helps to reduce the emissions from their own operations and helps to add more clean electricity to the power grids. They also invest in several carbon offsetting projects. This will help them to achieve the goal towards carbon neutrality in scope 1 and scope 2 emissions (AT&T Issue Brief, Climate Change, n.d.).

AT&T are practicing and implementing several projects to optimize the network functions and lower energy consumption. The intention is to eliminate energy consuming equipment within their operations.

AT&T believes that effective energy management is crucial for both the company's growth and environmental sustainability (AT&T Issue Brief, Energy Management, n.d.). There are numerous energy efficiency projects initiated by AT&T to reduce the energy consumption of the network hardware equipment. For any telecommunication operator, most of the energy consumption is driven by the network load and the purchased electricity accounts for 80% to 89% of the GHG emissions within their operations. To provide the telecommunication service, most of the necessary network hardware equipment is housed in a facility. Thus, the energy consumption of telecommunication operators could be regarded as two aspects, one is the heating, ventilation and air conditioning (HVAC) of the buildings and the other one being to power up the network hardware (Schulz J., personal communication, 17 March, 2022).

AT&T works with their network hardware providers such as Ericsson or Nokia to create more energy efficient hardware that ultimately lowers the energy intensity (a metric used to measure energy required to transfer a unit of terabyte data). Apart from energy reductions bound to network functionality, the real estate operations and the energy team of AT&T work together with solutions and energy efficiency projects to reduce the energy consumption in the buildings (HVAC). There are a few absolute metrics such as utility bills or measuring energy consumed by a building through a metering system to monitor the reduction in energy consumption at the buildings. Furthermore, AT&T having a huge real estate footprint with varying efficiencies and age has built an electronic building management system (EBMS) driven by IoT connections that has the capability to sense and collect data from buildings to find energy saving opportunities. Also, each building manager is provided with a score card that measures the maturity in implementation of these energy efficiency projects. Apart from energy efficiency, there are other scorecards related to other aspects of environmental sustainability such as water and waste management (Schulz J., personal communication, 17 March, 2022).

For the cooling of the network equipment, water is a critical input. AT&T uses smart irrigation systems to manage and conserve the water. Furthermore, regular cleaning and maintenance of the cooling towers increases efficiency and reduces water consumption

AT&T plans to enhance the efficiency of their network infrastructure, the target is to have carbon savings around 10 times the footprint of their operations. This they plan to achieve by virtualization of several of their network functions (AT&T Issue Brief, Climate Change, n.d.). Virtualization is a way to convert a hardware function into a software function in order to eliminate energy intense network equipment. AT&T considers the circularity hierarchy principles and thus, reuses or repurposes the eliminated equipment or even resells it to a secondary market and as a last option, AT&T works with certified recycling vendors to generate revenue and close the resource loop through recycling (Schulz J., personal communication, 17 March, 2022). Reducing energy consumption and a shift to renewable energy along with an increased capacity of its onsite production significantly reduces the GHG emissions associated with energy consumption. To enable this reduction in consumption and shift to renewable energy, AT&T has taken – up these three approaches, i.e., investing in purchasing of large-

scale renewable energy contracts, reduction and right sizing their assets and optimizing them (AT&T Issue Brief, Energy management, n.d.).

AT&T's Ground fleet operations constitute 52.3% of total scope 1 emissions and thus, they have measured the GHG emissions from their ground fleet operations and are working towards reducing these emissions. AT&T´s efforts to reduce the emissions from these ground fleet operations include optimizing the route, minimizing the truck rolls, reducing the number of vehicles in operation and shifting towards hybrid vehicles along with a robust fleet management system. AT&T measures the following, global carbon footprint and GHG emissions intensity (scope 1 and 2 emissions/1000 subscribers), (AT&T Issue Brief GHG, n.d.).

Further, water management is a critical risk in telecommunication operations. AT&T knows that water consumption is critical to its operations and is actively working towards reducing water consumption as much as possible, especially in stressed areas that have water scarcity. Network optimization, asset decommissioning and right-sizing, apart from increasing energy efficiency, helps in reducing water consumption as well. Cleaning cooling towers, proactive maintenance and repair and smart irrigation systems help in reducing water consumption as well. The key metrics AT&T uses to monitor its water management are absolute water use in highly water stressed locations and water usage per subscriber (AT&T Issue Brief, Water Management, n.d.). In this regard, cooling towers within the facilities are the most intense water usage systems, efficiency projects relating to these cooling towers are AT&T's focus (Schulz J., personal communication, 17 March, 2022).

With respect to social sustainability risks within AT&T´s operations, they understand the importance of protecting human rights within their operations and to enable this, they have a human rights committee to monitor the implementation of their human rights policy. Modern slavery is one of the human rights risks that AT&T have identified and through the policies they ensure and mitigate such risks. AT&T communications has an Environmental, Health and Safety Management System in alignment with International Standards Organization (ISO) 14001 and Occupational Health and Safety Assessment Series (OHSAS) 18001 (AT&T Issue Brief, Human Rights, n.d.).

Due to the complex nature of the ICT sector, AT&T is committed to following the rules and regulations related to the safety and health of their employees. For the commitment to this issue an AT&T business code of conduct is outlined and should be reviewed by employees to understand its provisions. An intensive training is provided, and a training matrix is implemented on the use of EHS system relevant to the job responsibilities for employees based on the risks and tasks of the job. In case of emergency situations, a Business Continuity Preparedness Handbook is outlined to facilitate the best practice approach. The EHS performance is regularly assessed. AT&T communications conducts internal Environmental Site Assessments (ESAs) focusing on environmental regulations such as hazardous material storage and air emissions. The assessment helps to plan the prevention and mitigation of the risks identified. This overall helps them to remain committed and improve the performance and operations. A toll-free helpline number is accessible for all employees in order to report issues like

hazardous material spills and employee health and safety incidents (AT&T Issue Brief, EHS, n.d.). The sustainability risks identified within the N&T operations of AT&T and their mitigation approaches are summarized in Table 6.7.

Table 6-7 Summary of N&T's sustainability risks and mitigation within the operations of AT&T

	Risks	**Initiatives**	**Metrics**
Operations	The entire telecommunication operations are highly energy intensive and account to high scope 2 emissions from these telecommunication operators	AT&T sources renewable energy to power their operations and are involved in several power purchase agreements to reduce the emissions from consumed energy to run their operations. AT&T also invests and purchases large-scale renewable energy contracts	Share of operations run on renewable energy
	Effective energy management is crucial for both the company's growth and environmental sustainability	AT&T explores and implements numerous energy reduction projects. The objectives of these projects are optimizing network functions, lowering the energy consumption, virtualization of network functions and reduction and right-sizing of the assets	Total energy consumption, Total electricity usage, Energy intensity (energy/1000 subscribers) and Number of energy savings projects implemented and their savings
	AT&T's Ground fleet operations constitute 52.3% of total scope 1 emissions.	AT&T aims towards implementation of robust fleet management systems. This involves route optimization, optimization of the number of vehicles and low-emission transportation fleet such as electric vehicles	
	Apart from the emissions associated to the ground-fleet operations, there are	To track the progress of GHG emissions reductions from their	

	emissions generated due to the use of refrigerants, stationary engines, and fuels in their operations	operations, AT&T measures their global carbon footprint	
	Water management is a critical risk in telecommunication operations	Network optimization, asset decommissioning and right-sizing, apart from increasing energy efficiency, helps in reducing water consumption as well. Other projects associated to water management are cleaning of cooling towers, proactive repair and maintenance, and smart irrigation systems	Absolute water use in highly water stressed locations and Water usage per subscriber.
	Modern slavery is one of the human rights risks that AT&T have identified and through the policies they ensure and mitigate such risks.	To ensure human rights protection within its operations, AT&T has a human rights committee to monitor the implementation of their human rights policy. Further, they have a business code of conduct and should be reviewed by employees to understand its provisions	
	There are certain health risks associated to AT&T ´s operations because of the hazardous chemicals and materials storages and any spill of those chemicals	To monitor these risks, AT&T conducts environmental site assessments and have a toll-free number to report any incidents of hazardous chemical spill	Annual number of incidents of hazardous chemical spill

6.3.2 Supply Chain

AT&T has more than 20,000 suppliers globally. AT&T puts a high value and commitment towards conducting business with corporate responsibility and sustainability. They conduct business with high ethical business standards and integrity, at the same time they make sure their value chain and suppliers follow the same governance as them (AT&T Issue Brief, Responsible Supply Chain, n.d.).

Apart from scope 1 and 2 emissions, AT&T has measured their scope 3 emissions and major sources of these emissions are waste generated in operations, business travel, downstream leased assets and supplier emissions. Further, the major sources of these supplier emissions are purchased goods and

services, capital goods and upstream transportation and distribution. AT&T works actively to promote sustainable business practices. AT&T has set KPIs to measure the sustainability at their supplier's side, they have certain metrics to make sure of this. They make sure their suppliers track greenhouse gases and have specific emission goals. AT&T has a science-based target which compels them to work with suppliers having a science-based target on scope 1 and scope 2 emissions of greenhouse gases. AT&T supports the suppliers with this activity, they conduct supplier training and provide grants. Also, sustainability is one of the major criteria when making a sourcing decision for purchasing goods and services. The most important tool for AT&T to make sure about sustainability is that the suppliers abide by the principle of conduct for suppliers and follow the contract agreements. The focus is on promoting moral practices throughout the supply chain in terms of natural resource use, climate impact, water use, human rights, wastes and energy use (AT&T Issue Brief, Responsible Supply Chain, n.d.).

AT&T has outlined a code of conduct that the suppliers are compelled to follow, and which inculcates the environmental, social and governance (ESG) considerations. It focuses on topics such as Environment, health and safety, human rights, circular economy, ethics, sustainable business practices, conflict minerals, conflict of interests, freedom of association, labor practices, confidential information privacy, supplier diversity, confidential information and privacy. The suppliers are expected to demonstrate and practice code of conduct with the ESH policies (AT&T Issue Brief, Responsible Supply Chain, n.d.).

AT&T puts demands towards their suppliers from abstaining the use of minerals causing human rights issues and from the areas around democratic republic of Congo. AT&T makes their suppliers comply with the rules of conflict minerals ie the activities for mining of minerals which support the armed groups. It is a strict demand to restrict the use of conflict minerals in the product offerings to AT&T (AT&T Issue Brief, Responsible Supply Chain, n.d.). AT&T terminates the contracts of their supplier in case of non-compliance and reserves the right to audit the suspected suppliers.

As part of due diligent sourcing, AT&T has a thorough screening of suppliers against restricted-party lists from governments worldwide to ensure it does not conduct business with suppliers who pose risks with sustainability. Before offering contracts, AT&T has an onboarding set of questionnaires. Based on the answers from suppliers, they deploy risk mitigation to perform business and risk-specific compliance monitoring. They also inculcate contract clauses to mitigate risk engagements (AT&T Issue Brief Responsible Supply Chain, n.d.).

Further, AT&T evaluates their suppliers against TIA sustainability assessor scores developed with Telecommunications Industry Association (TIA) which help the suppliers to move towards best sustainable practices. With respect to the supplier policies and management practices TIA assess topics such as resource efficiency optimization, corporate social responsibility, environmental management, eco-design, supply chain management, carbon footprint and ozone depletion, end to end delivery, stakeholder engagement, circular economy life cycle. Suppliers receive score cards based on TIA assessor tool and AT&T helps the suppliers to plan operations towards reaching a high scoring. (AT&T

Issue Brief, Responsible Supply Chain, n.d.). With the help of this assessment tool, AT&T has been able to integrate sustainability performance metrics into 80% of the spend that amounts to about 400 suppliers of the total supply base. (Schulz J., personal communication, 17 March, 2022)

Owing to the complex telecom supply chains, modern slavery and use of conflict minerals in their products are a few probable human rights risks that need to be addressed in the supply chain. AT&T is a part of JAC which helps them to audit their supply chain on areas focusing on human rights, environment, health and safety, and ethics. JAC conducts on site audits with high-risk suppliers with social responsibility standards. The audit framework is based on SA 8000 and ISO 14001 standards (AT&T Issue Brief Responsible Supply Chain, n.d.). Most of these sustainability risks within the supply chain account to the tier-1 (67%) and tier-2 suppliers and the four major areas of concern where corrective actions are provided are health and safety, environment, working hours and business ethics (Schulz J., personal communication, 17 March, 2022). AT&T also uses a tool called Mobile workers survey, which gives insights into the supplier side employees working conditions without management intervention (AT&T Issue Brief, Responsible Supply Chain, n.d.). Apart from these audits, AT&T are always in direct contact with their suppliers through code of conduct, contract agreements to improve their sustainability performance within their operations and supply chain as well (Schulz J., personal communication, 17 March, 2022). The supplier code of conduct compels supplier in restriction of use of mineral of conflict within their goods and services provided for AT&T. AT&T creates transparency and communicates their goals with the human rights issues and confirms that they will never directly or indirectly benefit or finance the armed groups (AT&T Issue Brief, Responsible Supply Chain, n.d.).

Table 6-8 Summary of supply chain risk and their mitigation for AT&T

	Risks	**Initiatives**	**Metrics**
Supply Chain	Supplier emissions are one of the major sources for AT&T´s scope 3 emissions. The major sources of these supplier emissions are purchased goods and services, capital goods and upstream transportation and distribution	AT&T has set KPIs to measure the sustainability of their suppliers. AT&T evaluates their suppliers against TIA sustainability assessor scores which help the suppliers to move towards best sustainable practices. AT&T helps the suppliers to plan operations towards reaching a high scoring. Also, AT&T makes use of a principle of conduct for suppliers	These KPI´s aim to evaluate if suppliers measure their greenhouse gas emissions, have set targets to reduce them and if they are verified by SBTi
	Owing to the complex telecom supply chains, modern slavery and	AT&T conducts audits themselves or with JAC to make sure the suppliers comply with human rights adequacy,	Number of audits conducted,

	use of conflict minerals in their products are a few probable human rights risks that need to be addressed in the supply chain.	social sustainability. ATT also uses a tool called Mobile workers survey, which gives insights into the supplier side employees working conditions without management intervention. Also, the sourcing managers are trained on human rights policy to ensure responsible sourcing	Number of supplier non-conformities identified and mitigated, Number of sourcing managers trained annually

6.3.3 Circularity

To minimize the waste throughout its operations, AT&T works towards maximizing operational efficiencies, recycling, and responsible disposal. To enable this, AT&T has initiatives of potential resale of high-volume common materials within its internal network operations. The environment, health, and safety (EHS) organization at AT&T manages wastes generated by various operations such as construction and engineering, technical field services and mobility operations and they also guide the business units of AT&T on recycling of batteries and e-waste. To recover and recycle the network infrastructure assets, AT&T works with recycling companies that are R2 certified, which is a global certification awarded to companies with responsible electronic recycling practices. Copper and fiber-optic telecommunications wire and central office equipment are several scrap materials that are processed. Management of hazardous waste such as gas cylinders, aerosol cans, acidic wastes, batteries, contaminated soils, and contaminated liquids is a great concern for AT&T. To manage hazardous waste, AT&T tries to lower its consumption and increase recycling and then, incinerate or divert to landfills with necessary care as a last resort. To conclude, the key metrics used by AT&T to track and monitor its waste management are the amount of waste generated, reused, recycled, and sent to landfills (AT&T Issue Brief, Responsible Supply Chain, n.d.).

Table 6-9 Key findings regarding the sustainability risks and efforts by AT&T

	Risks	**Initiatives**	**Metrics**
Circularity	There is an enormous amount of waste generated by AT&T´s operations such as construction and engineering, technical field services and mobility operations. This includes hazardous waste such as gas cylinders, aerosol cans, acidic	AT&T works towards maximizing operational efficiencies, recycling, and responsible disposal. Also, AT&T works with recycling companies that are R2 certified to recover	Amount of waste generated, reused, recycled, and sent to landfills

	wastes, batteries, contaminated soils, and contaminated liquids	and recycle the network infrastructure assets	

6.4 Sustainability Work Within Other Customer Relationships

In this section, a description is made based on how the suppliers work with sustainability with their customers other than Volvo Group. The purpose of this section is to assess and understand how other customers like Volvo Group put forth their sustainability criteria. This initiative was to learn from the suppliers' customers about best practices such that Volvo Group can inculcate changes in order to move towards the goal of sustainability.

6.4.1 Telia

The other customers of Telia, like Volvo Group, also put forward criteria within sustainability. This is observed sometimes in the form of yes or no questions; for example, does your company have an Environmental management system (yes/no) or does your company has an ISO 14001 certification (yes/no). Whereas other customers put forward open questions like how can you support our sustainability goals with your solutions? Based on the maturity level of suppliers, the questionnaires differ. The more mature customers ask open questions to reach a partnership or collaboration on the road towards sustainability. The mature customers are more concerned with implementation of sustainability within their own supply chain. In the case of the non-mature customers, it was found that they just wanted to tick off the criterion put forth in the procedures of RFPs or vendor development etc. Also, the non-mature customers put forth questionnaires which are very general based on their business segment. The sustainability questionnaire is to make sure whether Telia is a responsible organization. This is sometimes rewarded and gives Telia a competitive edge in the form of premium prices of contract or extra points within customer assessment. So, it is a win-win situation for both the parties including society.

Telia also collaborates and partners with their customers in projects within sustainability. For example, in case of forestry, automotive and mining industry, they have deployed remote controlled vehicles with the help of IoT (internet of things), and AI. Also, the results of these projects are published publicly for knowledge sharing and information. Telia also collaborates with other customers for knowledge sharing. They collaborate with their customers by working with their long-term goals within sustainability and support them in their journey of sustainability. (Lindwall M., personal communication, 23rd March 2022)

Telia further mentioned that various customers evaluate the sustainability at Telia's side in the form of RFPs or some sort of questionnaires or within contractual agreements. This kind of process mostly takes places annually or biannually. Telia further mentions that they help their customers with their RFP questionnaires by supporting and guiding them. (Lindwall M., personal communication, 23rd March 2022)

Volvo can reduce the climate impacts of operating the service or using the equipment by adopting to the solutions provided by Telia. With the digital solutions offered by Telia this can be made feasible by moving the physical data to the cloud servers or reducing the travel by moving to remote based online meetings. The energy consumption by water use, electricity use can be tracked by the sensors and data analytics tools provided by Telia. Telia suggests the use of autonomous and remote steered vehicles should be deployed by taking advantage of mobility technologies, 5G which provides low latency. (Lindwall M., personal communication, 23rd March 2022)

In order to move towards circularity and reduce the amount of equipment owned, Volvo can lease the IT hardware and return it back to Telia after the end of use such that Telia can refurbish and keep it in the circular loop. Also, another such initiative as suggested by Telia is to make the usage of e-sims in the mobile telephony services. (Lindwall M., E-mail follow-up, 13th April 2022).

Telia's work with other mature customers for smarter steering of district heating or cooling for transportation or data analytic/crowd insights for city planning or remote steering of machinery as in case of Boliden, can be taken of great advantage in efforts of reducing the climate impacts and moving towards sustainability. (Lindwall M., personal communication, 23rd March 2022)

6.4.2 AT&T

Similar to Volvo Group, AT&T´s other customers put forth their sustainability demands through ESG sustainability surveys, inquiries and self-assessment questionnaires when sourcing telecommunications services (Schulz J., E-mail Communication, 26th April 2022). Rest of the discussions on how Volvo Group can work together with AT&T on sustainable development like AT&T´s other customers were mostly based on how telecommunication technology can be used within Volvo Group´s operations. According to AT&T, the novel broadband technologies such as IoT and 5G or edge computing solutions can be used by Volvo Group to make smart decisions and reduce their carbon emissions while solving the operational problems efficient and increasing revenue simultaneously. Further, using this connected technology allows Volvo to monitor its operations, asset utilization, predictive maintenance and improve sustainability performance across its assets to drive efficiency, reduce the associated emissions, (Schulz J., E-mail Communication, 26th April 2022). Apart from the benefits of the connected technology in Volvo Group´s operations, it is beneficial for Volvo Group´s customers as well. Volvo Group, by collaborating with AT&T, can improve the environmental performance of the customer´s vehicle fleet by taking smart decisions, (Schulz J., E-mail Communication, 26th April 2022)

7 Discussions

In this chapter, the findings of the study will be analyzed and discussed based on both the theoretical framework and the literature review performed regarding the sustainability risks within the network and telecommunication industry. The aim of the discussion chapter is to analyze the literature review and the findings to answer the research questions that are formulated for the study. The structure of this chapter follows the research questions starting with identification and mitigation of sustainability risks within N&T industry, followed by discussing how Volvo Group can implement responsible sourcing through supplier selection and follow-up. Towards the end, this chapter presents the discussion on how Volvo Group can engage with the telecommunication service providers on various sustainability initiatives

In order to follow the discussion in the upcoming sections, it is important to understand the scope 1, 2 and 3 emissions as presented in figure 7.1. According to GHG Protocol (2013), scope 1 emissions refer to the emissions associated with the operations of an organization and these emissions are completely under its control. The scope 2 emissions are the emissions associated with production of energy that an organization procures. Lastly, the scope 3 emissions are the ones associated with suppliers, distributors and product use stage. These scope 3 emissions account for more than 70% of an organization´s carbon footprint in most of the cases (Aldridge, 2016)

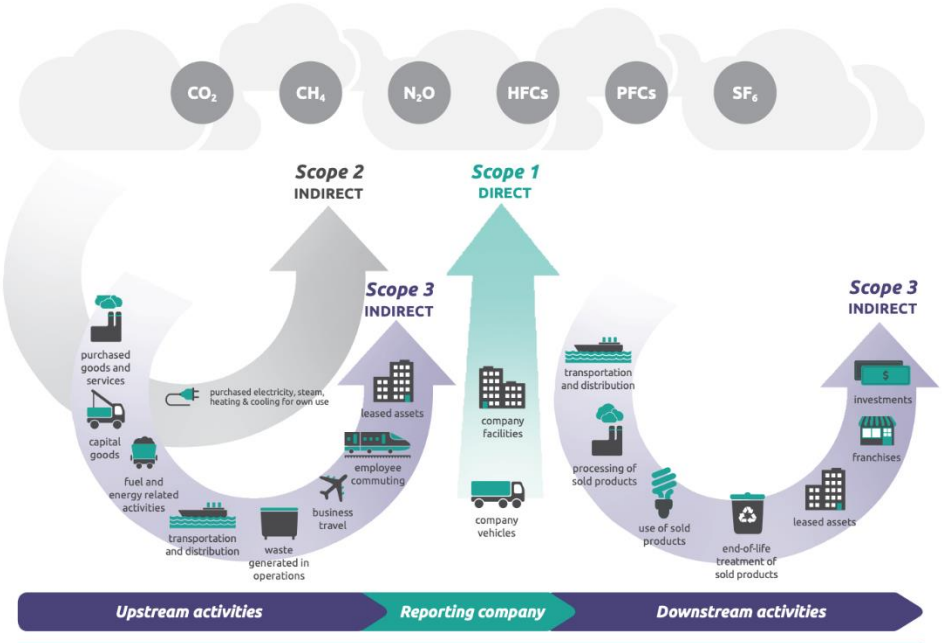

Figure 7-1 Scope 1, 2 and 3 Emissions as Defined by Greenhouse Gas Protocol (Source: GHG Protocol, 2013)

Further, in this section, the suppliers interviewed in the study are referred to as either telecommunications service providers (TSPs) or telecommunication operators (TCOs). The suppliers of these TSPs or TCOs are referred to as "TCO´s suppliers" or the case company´s extended supply chain. To facilitate better understanding of the discussion section, figure 7.2 highlights the various actors involved and sets the scope for the discussion.

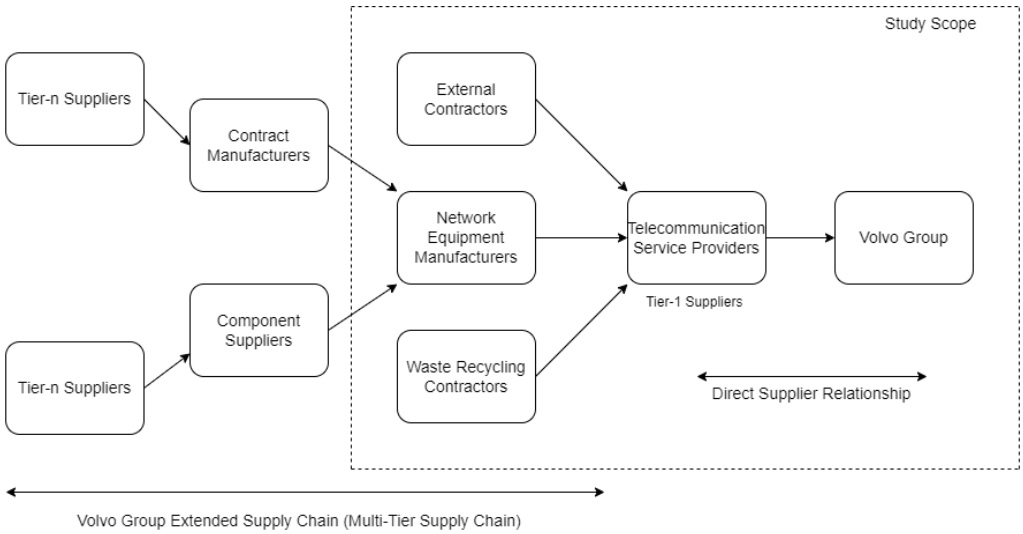

Figure 7-2 Supply Chain Scope Considered in the Study

7.1 Sustainability Risks and Their Mitigation Within N&T Industry

The identified risks and their mitigation are presented in this section starting with the overall climate risks, followed by detailed environmental risks within the operations and then the supply chain of the telecommunication operators. Then, the risks around waste management and circular economy, followed by social sustainability risks within the industry as conclusion are presented. The literature review performed in the study contributed to determine the sustainability risks within the N&T industry and the interviews conducted confirmed the presence of these risks. Further, the findings from the interviews helped in understanding how big the extent of each risk and the best practices followed by TCOs in mitigating these risks. Apart from helping the case company in evaluation of TCOs, the discussion in this section can be helpful in sharing the knowledge of the best practices in mitigating the risks to different industry actors including other TCOs.

7.1.1 Carbon Footprint

Telecommunications is one of the most energy intensive sectors accounting for approximately 4% of the global power usage for its operations. There is an ongoing rapid growth of the network and telecommunication (N&T) industry due to immense technological innovations and its benefits to various other industry sectors, (Matthews et al., 2010). This growth in the N&T industry has resulted in a higher carbon footprint because of the extensive power usage to power up the network operations and facilitate telecommunication.

Looking into the N&T industry, there are various actors such as component suppliers, equipment manufacturers, network equipment distributors and telecommunication operators. This review of the different actors in the N&T industry shows that the telecommunication operators owning the network infrastructure, operating it, providing telecommunication services and engaging with customers (both business and private customers) are the focal companies. According to Seuring and Müller (2008), focal companies are responsible to ensure sustainability within the industry. The TCOs are the focal companies in the N&T industry and thus, they play a major role in ensuring the industry´s sustainability. The TCOs are exploring approaches to lower their carbon footprint. To ensure a sustainable growth of the N&T industry, they are setting targets and goals that are verified by "Science Based Targets Initiatives (SBTi)". Apart from long-term sustainability targets and goals, the suppliers have set interim goals as well. Verifying these long-term and interim goals by SBTi ensures scientific relevance and validity of the set goals to mitigate the climate risks by limiting the global warming to 1.5º C. Along with verifying their climate action goals by SBTi, the TCOs have set a target to ensure that their suppliers have climate action goals that are verified by SBTi. This target helps the telecommunication operators in lowering their scope 3 emission and ensures a sustainable supply chain.

Two of the suppliers interviewed, Tele2 and Telia, in their efforts towards lowering the carbon footprint are already 100% climate neutral within their own operations. AT&T aims to become climate neutral in their scope 1 and scope 2 emissions by the year 2035. Tele2 has offset their scope 1 and scope 2 emissions by using carbon removers and purchasing 100% renewable electricity. In efforts to carbon neutrality, Tele2 invests in renewable energy projects in developing countries like India. Additionally, projects to avoid deforestation and purchase of carbon credits are some of the initiatives undertaken as part of combating global warming. Similarly, Telia and AT&T use carbon removals to offset the emissions which cannot be eliminated. Telia uses biological and industrial carbon removals to offset the emissions from activities like fossil fuel combustion for backup power or company car fleet etc. However, the aim for any TCO should be to achieve net-zero value chain emissions to achieve the Paris agreement goals. Reaching net-zero involves reducing the emissions as much as possible and then offsetting the remaining emissions which cannot be eliminated.

In order to achieve the set goals, the TCOs have initiated sustainable development efforts by setting up a sustainability strategy with a structured approach. One of the focus areas within Tele2´s sustainability strategy is advancing circular economy to combat climate change which involves Tele2´s work towards circular business models, reducing scope 1 and scope 2 emissions, and achieving a net-zero value chain. Another focus area within Tele2´s sustainable strategy is boosting innovation within their technology and operations. This focus area investigates technological developments and their applications to reduce their total carbon emissions.

Similarly, Telia has pointed out climate and circularity as one of the focus areas of its sustainability strategy. As part of its efforts on mitigating climate risks within this focus area, Telia believes that electricity consumption is one of their most significant environmental aspects and they continuously

explore on how to reduce electricity consumption and shifting towards sourcing of electricity from renewable sources. Further, Telia strives towards creating a climate neutral value chain by considering scope 3 emissions and not just scope 1 and scope 2 emissions.

Like Tele2 and Telia, AT&T have a sustainability strategy and as part of it, they assess the risks internally through risk management tools and one of their important goals is to develop a roadmap investigating their GHG emissions. To operationalize the sustainability strategy, AT&T works with various energy efficiency projects to reduce their emissions from operations and engage with suppliers to ensure responsible sourcing. Although all three suppliers have different focus areas within their sustainability strategy, the ultimate problem they are striving to address is the same.

The sustainability risks are not limited to the operations of the telecommunications sector, the supply chain of the telecommunication operators also amounts to equivalent unsustainable practices and thus, higher carbon footprint. The importance of addressing scope 3 emissions associated to the upper stream suppliers and their operations is important. This is because of the reason that there are emissions associated to the manufacturing and the transport of the various network equipment and components and these emissions account to more than that of scope 1 and scope 2 emissions of the total emissions associated with the N&T industry. The scope 3 emissions being greater than that of the emissions from own operations is due to the reason that N&T is a service-based industry, and this holds true for many other service sectors.

A review of the literature revealed that supplier selection and thorough investigation of the risk and risk factors at the different stages of the N&T industry are critical to ensure sustainability in the multiple tiers of supply chain. As noted by Seuring and Müller (2008) in their sustainable supply chain management framework, the telecommunication operators being the focal companies evaluate their suppliers on various sustainability factors and engage and communicate with them to improve the sustainability performance.

It was noted that the TCOs use various tools and mechanisms such as sustainability questionnaires, onsite audits, and code of conduct to evaluate and engage with their suppliers in the sustainability work. The sustainability questionnaire is not just used as a supplier evaluation criterion, it is also used to estimate the maturity of the suppliers to identify the potential risks and establish a risk management strategy. Further, Telia´s investigation of their supply chain emissions revealed that 80% of the supply chain emissions are associated to its top 100 suppliers. Thus, it is critical for Telia to collaborate with these top suppliers by using the above-mentioned tools and mechanisms more extensively to achieve a significant reduction in their supply chain emissions. It is also important to note that sustainable sourcing is not just a matter of supplier evaluation and choosing the best one.

Collaborations with educational institutions and industry associations to improve the overall sustainable development of the N&T eco-system are also emphasized by the interviewed TCOs. Tele2 is a part of several research projects such as “AI4Green” and “SooGreen” that study and explore innovative solutions to achieve energy efficiency in the mobile network. Similarly, Telia collaborates with

organizations such as GSMA and ETNO to publish white paper reports and assist in legislative policy development to achieve new technologically innovative solutions to sustainability issues and share the knowledge with other industry actors for the overall industry development. Also, Telia has joined 1.5°C supply chain leaders' group, which works towards establishing approaches to engage with small and medium sized suppliers and help them in sustainable development. These collaborative efforts are critical in setting a standard in the industry for best practices. From the telecom operator´s perspective, such efforts help them to be a top player in the market and resilient through early identification of risks and their management.

Assessing the broader climate targets of the suppliers and their approach towards achieving them reveals the sustainability maturity of the suppliers. By analyzing the various initiatives taken by the suppliers to reduce the emissions from their own operations and supply chain and analyzing their collaborative efforts with other industry actors will help the case company in responsible sourcing. Thus, broader analysis of the supplier climate targets and their approach towards achieving them helps the case company in selecting the right supplier, who in turn contributes significantly to achieve the climate targets of the case company by aligning to them.

Table 7-1 Summary of steps taken to reduce the carbon footprint

Sl no	Steps Taken to Reduce the Carbon Footprint
1	Setting up sustainability targets that are verified by SBTi.
2	Investing resources in carbon off-setting to achieve carbon neutrality
3	Technologial innovation and energy saving projects to reduce the carbon footprint from the operations
4	Demanding suppliers to set sustainability targets and get them verified by SBTi.
5	Responsible sourcing through use of sustainability questionnaires, onsite audits, and supplier code of conduct
6	Collaboration with external partners to find ways on reducing the N&T industry carbon footprint

7.1.2 Energy

Source of Energy

The operations within the N&T sector leads to high energy consumption (Canfora et al, 2020) to facilitate communication between two users by transmitting signals via base stations or switching centers that consume energy. Scope 2 emissions, i.e., emissions associated with the production of energy that is sourced by an organization, are significant in the network and telecommunications industry. There is a two-fold reason for the scope 2 emissions being higher. The source of the energy contributes to varying levels of emissions and the other reason being, higher energy consumption in the N&T industry leads to higher scope 2 emissions (Canfora et al., 2020). There are various energy

production methods, the traditional amongst them is from the usage of fossil fuels such as coal and petroleum, this energy production based on fossil fuels has huge carbon emissions. Energy production from renewable sources such as hydro-power, solar and wind have relatively lower carbon emissions in comparison to those based on fossil fuels. It was observed that all three suppliers are in search of solutions to source energy in an environmentally friendly manner.

Emissions from fossil fuels are observed in the ground fleet operations of TCOs as well. The vehicles present in these ground fleet operations when they run on fossil fuel sources contribute to a TCO´s emissions. According to AT&T, 51% of their scope 1 emissions result from these emissions associated with the usage of fossil fuels. Thus, AT&T are finding alternatives to eliminate or reduce these emissions by electrifying their fleet along with robust route management to reduce these emissions.

Telecommunication operator´s transition towards sourcing of energy produced based on renewable sources significantly influences the reduction of scope 2 emissions, which in-turn produces a positive impact on Volvo Group´s value chain emissions within the N&T sourcing. However, this transition of the operators towards renewable energy depends majorly on the maturity of the geographical region that they are operating. Developed countries provide necessary infrastructure for renewable energy production in comparison to that of countries that are in developing phase (Sutherland, 2009). Thus, the market in which these telecommunication service providers operate determines the pace of transition towards sourcing of renewable energy to some extent.

The TCOs have set targets on sourcing of 100% renewable energy. Further, as a milestone in achieving this target, Telia and Tele2 have already achieved 100% usage of renewable electricity in their operations and Tele2 provides certificates that guarantee the origin of the sourced renewable electricity. All three suppliers reviewed in this study are in developed countries and thus, they have matured renewable energy sourcing initiatives and targets. In the case of a telecommunication service provider located in developing countries, assessing the use of renewable energy in their operations and considering this factor for evaluation will be necessary. Although all the reviewed suppliers source 100% renewable electricity, there is still a long way to achieve 100% renewable sources in the entire energy requirements of the N&T operations.

Although renewable energy is a more sustainable source of energy because of its low impact on the environment, many telecommunication operators are still facing challenges in its adoption. The major challenges noted in the literature regarding the procurement of renewable energy are the continuous availability of the source of energy due to seasonal variations and lack of robust power storage systems (Mohanty & Moreira, 2014). Table 7.2 summarizes these challenges. It seems that the TCOs perceive the challenges in achieving the target in a varied manner depending on the weightage that they allocate to each challenge. For instance, Telia collaborates with other business partners from the battery industry to explore innovative solutions to deploy used batteries such as those from the automotive industry as energy storage systems for power back-up.

On the other hand, AT&T being a largest purchaser of solar energy, has engaged in several power purchase agreements (PPA) with the developers of renewable energy as an approach to mitigate the challenge of uncertainty in the availability of renewable energy. PPAs are essentially long-term contracts between business organizations and renewable energy developers to secure the energy capacity directly from the producers. Apart from enabling the telecommunication operators to reduce their scope 2 emissions, engaging in such long-term contracts provides them with a financial benefit of set prices as per the agreement without any price evolution. Other approaches emphasized in the literature to mitigate the challenge of supply uncertainty is to consider hydrogen fuel cells as an alternative source of energy and deploying hybrid systems comprising of solar photovoltaic cells along with wind turbines (Singh et al., 2012). To increase their effort in mitigating the availability risk, AT&T has invested in developing onsite renewable energy production capacity through installations of solar energy and fuel cells, which ultimately increases the reliability and longevity.

Table 7-2 Challenges in sourcing renewable energy and its mitigation

Challenges and Opportunities	**Supplier Approach**
Uncertainty in the availability of renewable energy	AT&T invests resources in securing power purchase agreements and onsite renewable energy production.
Lack of efficient and robust energy storage systems	Telia exploring used batteries as back-up energy storage systems

Network Equipment

Energy consumption to power up the network infrastructure to provide the telecommunication services is the major contributor to both the operating costs and the emissions of the telecommunication operators. Hence, it is important to reduce energy consumption and make the network infrastructure energy efficient from both the economic and environmental sustainability perspectives.

According to Rittenhouse et al. (2011), a reason for high energy consumption in both wired and wireless telephony services is inefficient network equipment and its set-up. This inefficient network equipment and set-up contributes to about 85% of energy losses (Nokia, 2016). These are the potential areas in which efforts and improvements are required for energy savings. In the case of wireless telephony, energy wastage is due to energy transmission through the air, whereas for wireline telephony, the routing and switching consumes the most energy. (Rittenhouse et al., 2011). Energy consumption is higher during high traffic for routing and switching (Tucker, 2012). Potential energy saving in the network infrastructure can be obtained by sourcing efficient network equipment and continuous improvement projects in identifying the best operational set-up with innovative solutions by the telecommunication operators.

TCOs are making efforts towards lowering their energy consumption through power saving techniques due to the customer demands and trying to lead in their sustainability development. Tele2 collaborates

with universities conducting technical research and other telecommunication operators in research projects with an objective to reduce the energy consumption in their mobile networks by improving the network architecture. Currently, Tele2 works on a project named “AI4green” that studies the optimization of power consumption based on artificial intelligence applications to gain energy savings. In a similar project named “So Green”, Tele2 achieved the objective of energy savings by being able to switch off the power amplifiers of base stations for milliseconds during no data traffic period. The duration for power off was chosen to be very low in order to avoid hampering the quality-of-service offering. This solution was deployed in their base-stations to switch the power amplifiers to standby during non-operation which resulted in significant energy savings.

The base stations contribute to a large amount of energy consumption within the cellular network and particularly power amplifiers & transceivers of the base stations are the most energy intensive components, (Huawei, 2020). The base station consumes a stable amount of energy even when it is not transmitting the data. In the idle state the base station is active to send the mandatory signals like system information, synchronization signal etc. Power saving can be obtained by turning off the energy consuming components during idle state. An effective approach for implementation of this activity is using AI and IoT. The quick automated decisions in real time regarding power on/off of the components is obtained by analyzing the vast amount of data with respect to the traffic patterns. The discussed energy saving methods sometimes take longer duration to power up a base station that leads to potential loss in the service quality, which is identified as a limiting factor in adopting these energy saving methods.

In some cases, it is not sufficient to improve the operational set-up and the network architecture to gain energy savings because of the presence of legacy network equipment in the infrastructure that are energy inefficient. Telia´s approach towards power consumption management targets the problems associated with the legacy equipment. Network modernization involving replacing the old equipment with newer efficient equipment is one of the steps taken by Telia. Telia´s approach is supported by the literature that notes that the design and deployment of green network equipment with lower power consumption can be achieved with no significant loss in the service quality, (Singh et al., 2012). Tele2 has a similar approach towards network modernization as they are rolling out base stations with power-saving components making them energy efficient. This is because the new modernized equipment has more efficiency in terms of energy per unit of data transferred capacity which helps in lower power consumption. However, decisions on network modernization need to consider the aspects of resource consumption, circularity, and financial benefit.

AT&T´s approach on eliminating network equipment involves two methods, one is collaborating with network equipment providers such as Ericsson and Nokia to design and deploy more efficient equipment and the other method is virtualization of network functions. Virtualizing the operations of the network functions involves replacing the network hardware with a software system. The main aim of virtualization is to provide higher efficiency, utilization rate and automation leading to cost reduction

and more efficient energy management. This approach of virtualizing network functions is used by Tele2 as well and according to them, virtualization is expected to bring 10 times more energy savings.
Apart from these various energy savings projects discussed, there are several other projects such as the use of flexi base-stations and optimization of network software that are discussed in the literature but were not mentioned during the supplier interviews. Flexi base-stations are smaller sized base-stations that are defined based on software which contributes to reducing the energy consumed by these base-stations. Further, the energy efficiency of these flexi base-stations can be improved with regular software updates, (Singh et al., 2012). Telecommunication operators develop software systems to run other network equipment as well and not just the base stations. Considering the energy saving opportunities while developing these software systems is important as processing and transmission of data can be optimized to achieve reduction in energy consumption, (Canfora et al., 2020).
Implementing energy savings projects not only has a positive impact on the environmental sustainability, but also on operating costs due to the increasing energy price. However, these various energy savings projects discussed require certain capital investments in certain situations and thus, decisions on taking-up such projects need to consider the business perspective as well (Matthews et al., 2010). Making use of innovative technological solutions such as artificial intelligence requires investment. Telia, working with network modernization, shared the concern that replacing old equipment with newer ones is not always viable in all scenarios. This is because in certain cases the old equipment has not reached its end-of-life cycle and thus it is uneconomical to replace.
Measuring and tracking the progress is an important aspect of any project. For this reason, there are several management systems present to track the current energy consumption of the network infrastructure. These management systems are used to measure the improvements achieved by the implementation of various energy savings projects. EU Eco-Management and Audit Scheme (EMAS) and Environmental Management System (EMS) are two such management systems that provide guidance to manage various risks to the telecommunication operators. High energy consumption is one such risk, for which these management systems provide metrics such as energy used / 1000 subscribers or energy used to transfer 1GB of data which can be used as a baseline to verify the effectiveness of the energy savings projects.
To conclude, energy consumption is one of the major sustainability risks within the N&T industry and to mitigate this risk, the telecommunication operators are researching on continuous improvement projects with reducing energy consumption as the objective. From the case company´s perspective, it is important to request information on the energy saving initiatives of suppliers and validate the initiatives and thus, the suppliers. The case company needs to ask various energy related metrics that the supplier uses to track the projects progress as part of the supplier evaluation process. Table 7.3 summarizes the various energy savings initiatives.

Table 7-3 Summary of examples of energy saving initiatives

Energy Saving Initiatives	Description
Equipment standby	Energy intense equipment in the network architecture can be put to standby during the non-operation phase without any loss in the network quality.
Network Modernization (Include flexi-base station)	Replacing old network equipment with newer energy efficient equipment. Use of flexi base-stations in the mobile telephony network is one such example.
Virtualization of network functions	Replacing the network hardware with software systems intended to perform the same function as that of the hardware equipment. There is a reduction in resource consumption as well.
Software system development	Software systems are used to operate the network equipment, considering energy saving objectives during their development is beneficial.
Use of management systems	As part of the energy saving initiatives, use of management system helps in tracking and monitoring the progress.
Product development of energy efficient network equipment	Collaborating with equipment suppliers during the design and product development stage of the network equipment provides energy savings once deployed in the network.

Network and Telecommunication infrastructure

Network infrastructure refers to various huge physical infrastructures in which all the network equipment is housed in a network node. In the network architecture, there are several network infrastructures sites such as telephone towers, base station housing, mobile switching centers in the case of mobile telephony. Similarly in fixed telephony, major network nodes are routers and switching centers that are connected through wired cables. These switching centers are essentially datacenters that comprise data of end-subscribers of the telecommunication services and with the help of this data, the switching centers can connect different users. There is a risk of high energy consumption in the network infrastructure sites because of bad design or lack of consideration given to environmental sustainability risks during the design phase. Heating, Ventilation and Air-Conditioning (HVAC) is an area responsible for most of the aspects of bad network infrastructure design. A report published by Telia emphasizes the use of digital solutions to monitor the real time requirements of the buildings through sensors optimize as an approach to optimize and reduce the network infrastructure energy consumption. Additionally, construction activities and the materials used in building of the network infrastructure contribute to environmental impacts as well.

Telecommunications help us to stay connected and this puts pressure on the industry to operate continuously, due to which the base stations and data centers operate continuously even during no data transfer causing high energy consumption. This high energy consumption leads to a huge amount of heat generation. To dissipate this heat from energy intensive equipment, bulky air conditioners are being deployed. This air-conditioning along with other heating and ventilation equipment (HVAC) leads to high energy consumption in the network infrastructure. It is important for telecommunication operators to design these sites in such a way that HVAC energy consumption is low.

Managing the HVAC energy consumption is a challenge to an extent that AT&T have a dedicated real estate operations and energy team. The main responsibilities of this team are to initiate energy efficient projects and investigate the effectiveness of these projects through tracking and monitoring of metrics. One such key metric is the energy consumption of each network site measured either through energy bills or via sophisticated metered systems. AT&T´s network infrastructure is so vast that they have built an electronic building management system (EBMS). EBMS, based on IoT driven connections, collects millions of data-points, and determines potential opportunities for energy savings in the infrastructure. AT&T's network infrastructure varies in terms of efficiency and age to a great extent, which makes it difficult to scale energy efficiency projects from one site to another. To mitigate this issue, AT&T has made each building or site manager responsible for energy savings at their respective sites by providing them with an energy scorecard.

Cooling of servers and IT equipment present in the datacenters consumes immense energy and Telia to deal with this energy consumption have developed an innovative concept named the "Green room concept" that are being used in their datacenters in the Nordics. In this solution, Telia makes use of smart systems to handle cooling of these equipment resulting in enhanced efficiency. To develop this green room concept, Telia collaborated with "SEE Cooling", a supplier of energy efficient cooling systems. As a result, Telia´s green room concept involves energy efficient optimized free cooling and is also equipped with a capability to use geothermal energy during peak loads and thus, making it a robust cooling system, (SEE Cooling, n.d.). Free cooling is natural cooling by the surrounding atmosphere without any intervention from external systems. However, natural air cooling can act as a limiting factor due to the presence of humidity in the atmosphere which might deteriorate the metal parts or other electronic components. To tackle this problem, liquid cooling can be inculcated which uses water as the coolant to dissipate the heat generated. The heat dissipated from the servers and other equipment in the network infrastructure can be reused for various purposes. Reusing energy reduces resource consumption and enhances circularity. Telia in their green room concept of datacenters reuse the waste heat energy in district heating systems.

Apart from high energy consumption by the cooling systems in the network infrastructure, water management is a critical risk as well. The issue of water management is a critical issue especially in water stressed regions, where there is a high-water scarcity. To mitigate this issue, Tele2 tries to deploy free cooling at all possible infrastructure sites. Opting free cooling methods is governed by the location

of the infrastructure site to some extent. For example, in the Nordics, most of the year the outside temperature is cooler, making free cooling a viable option compared to other regions in the world that are located near to the equator. Apart from free cooling, Tele2 makes use of sea water cooling that uses sea water as a coolant in its sites that are near to the sea. It was observed that AT&T uses water significantly in their cooling systems and are on the agenda of continuous reduction, especially in the water-stressed locations. Their initiatives with respect to water management involve proactive maintenance and repair of cooling systems, and smart water irrigation systems. Timely maintenance and repair of cooling systems enables efficient cooling with minimal water consumption. Further, the metrics that AT&T use to monitor their water management are absolute water use in highly water stressed locations and water usage per subscriber. In certain cases, there may be limitations on using natural air cooling and water-cooling systems, thus making air conditioning the only viable option. Tele2 is making efforts to map their use of refrigerants, to replace them with eco-friendly refrigerants.

Manufacturing and transport of infrastructure site elements and the type of materials used for their manufacturing contribute to environmental sustainability risks within the operations of the telecommunication operators. For instance, traditional cell towers are made of steel, aluminum and are placed around concrete structures. The usage of these raw materials in the tower construction and installation has negative impacts on the environment. Chase (2022) recommends the use of composite material such as glass fiber for the manufacturing of infrastructure site elements. The use of such sustainable material in the manufacturing of the site elements provides significant improvement. A similar innovation by Ericsson is their "Tower Tube" that is made of concrete and is better than the traditional steel. Most telecommunication operators levy the responsibility of the construction and maintenance activities onto external contractors and thus, they need to be monitored due diligently for lowering the negative impact on the environment.

Although the design of the network infrastructure is in control of the telecommunication operators, right supplier selection and collaboration with these suppliers is necessary to mitigate the associated risks. Collaborating with sustainable suppliers helps the telecommunication operators in implementing novel solutions in their operations. Risk mitigation initiatives discussed for efficient cooling systems are bound to the geographical region of the infrastructure site and hence, it needs to be given consideration while evaluating the suppliers. Further, the water management and energy management metrics discussed will facilitate supplier evaluation and follow-up.

Table 7-4 Risks and mitigation in the N&T infrastructure

Risks	**Mitigation**
Energy consumption in the network infrastructure (HVAC), i.e the housing for all network equipment	• Use of digital solutions to optimize the energy consumption of network infrastructure • Building management systems

	• Free cooling • Energy reuse • Alternative refrigerants
Water consumption in the network infrastructure	• Free cooling • Proactive maintenance and repair of cooling systems • Smart water irrigation systems
Use of unsustainable construction materials (steel, aluminum, concrete) and construction activities	• Use of sustainable materials such as composites • Sustainability demands on external contractors

7.1.3 Use of Hazardous Substances

In comparison to other industry sectors, the telecommunication industry does not handle a significant amount of hazardous chemicals and materials, (IFC, 2007). However, even the small number of hazardous materials present needs to be taken care of. This section discusses the environmental sustainability risks associated with the usage of hazardous materials in the telecommunication industry and its mitigation. Within the operations of the telecommunication operators, most of the hazardous materials are present in coolants, back-up power systems and the ground fleet vehicles, (IFC, 2007). Also, the electrical and electronic equipment that are sourced comprise of certain hazardous materials and these materials cause sustainability risks at the telecommunication operator´s site during waste management at equipment´s end-of-life.

The use of hazardous substances can be observed in the power back-up systems required to power up network infrastructure and its equipment in emergency periods. Nickel-cadmium batteries, lead-acid batteries and diesel generators are the different power back-up systems used in telecommunication operations. The maintenance activities at the network site will involve the workers to service the backup power system, like changing the oil for the generators. During maintenance there is a high possibility of accidents which might result in oil spills or contact with workers with hazardous chemicals.

In the case of the maintenance activities for an air-conditioner which involves handling of the harmful refrigerants made up of CFC gases. In case of mishandling of these refrigerants and their release to environment will cause harmful impacts on both environment as well as the humans. During the operation of the network equipment there is a high chance of seepage and leakage of hazardous chemicals into the environment.

The network equipment, servers and other IT equipment housed in the network infrastructure heat-up because of the continuous operations and high energy consumption. Cooling systems are used in the network infrastructure sites to cool the heat dissipating equipment and these systems make use of

refrigerants that contain fluorine. Use of fluorine compounds in the cooling system as coolants has a negative impact on the environment by depleting the ozone layer and increasing global warming (Sutherland, 2009). In their efforts towards reducing the use of refrigerants as coolants, Tele2 is mapping the refrigerants usage in their operations to eliminate them. A major challenge that they are facing with regards to eliminating the refrigerants is that the cooling systems in which the refrigerants are used have not reached their end-of-life yet, making it economically not viable to discard them.

In order to mitigate the risks associated with the handling of hazardous chemicals, telecom operators can implement a management system, which helps to manage, monitor and mitigate the risks associated with hazardous chemicals. For example, providing regular training to the workers for maintenance activities, conducting chemical hazards drills for oil spills or chemical leakages. Another way of reducing the risks associated with hazardous chemicals is to avoid the use of harmful chemicals. This can be done in two ways, that is the use of equipment that is certified by international standards. As well as finding an alternative for the current equipment containing hazardous chemicals by phasing out old equipment and replacing it with new environmentally safe equipment. Responsible disposal needs to be taken up, only as the last resort when eliminated their usage is impossible.

There are various directives and legislation policies that provide guidance to the telecommunication operators on mitigation of risks associated to use of hazardous materials. Tele2 follows the environmental impact assessment ordinance and the REACH regulation. According to the REACH regulation, the telecommunication operators should report the use of certain chemical substances listed under the regulatory policy if they import more than a tonne in a year. Telia, in their effort towards mitigating these risks, have prepared a list of black and grey items based on global and national legal requirements and use it as a checklist to avoid these substances in their operations.

As noted earlier, AT&T have identified the presence of hazardous substances in gas cylinders, aerosol cans, batteries, and acid wastes. Managing this risk associated with these items has been one of their major concerns and are handling it by lowering their consumption and responsible disposal. In this effort, AT&T conducts internal environmental site assessments that identify the potential risks with regards to use, storage and waste management of hazardous chemicals and their prevention plan.

Likewise, to conduct supplier audits, it is important for telecommunication operators to consider conducting internal site audits to identify the most common risks and scale the best practices across all the sites. Spillage of hazardous chemicals causes damage to the surrounding environment and human health; thus, AT&T have provided their employees with a toll-free number to report these issues. It is also important to note that providing training to employees on various hazardous substances present at the site operations and proper methods to handle each of these substances is beneficial and reduces the occurring of adverse events.

Apart from the use of hazardous materials in the operations of the telecommunication operators, there is a significant amount of these substances present in the sourced electrical and electronic network equipment. The use of hazardous materials in the network equipment has a two-fold effect, one is that

associated with the mining and transformation of these materials and the other with the disposal of these equipment. Mining and transformation of the raw materials to manufacture the network equipment causes environmental degradation around the mined areas. On the other hand, when these network equipment ends in landfills, they release toxic chemicals into the surrounding land, water, and air. Thus, it is necessary for the telecommunication operators to assess the suppliers and ensure reduction in use of such hazardous substances to manufacture the network equipment.

All three suppliers use various tools to assess their suppliers regarding these risks and evaluate and follow-up to increase their performance. Tele2 awards each supplier a score and conducts onsite audits for low scoring suppliers. Similarly, AT&T makes use of the TIA scorecard that includes clauses on the use of hazardous substances and their risks. They engage with suppliers having low scores to improve their performance. Telia uses clauses in relation to the risks with hazardous chemicals in their supplier code of conduct and verify the absence of these hazardous substances in the products that they source.

Understanding the risk associated with the use of hazardous substances and its mitigation strategies helps the case company to assess the telecommunication provider. With the help of this assessment, the case company can visualize the potential risks within its entire supply chain, ultimately helping it to source responsibly. Table 7.5 summarizes the risks associated with hazardous chemicals and their mitigation.

Table 7-5 Hazardous chemicals risks and mitigation

Hazardous chemicals present in N&T	**Mitigation**
Back-up power systems	• Management systems • Training the employees • Legislative directives (REACH regulation, ROHS directives) • Internal site audits
Cooling systems	
Supplier operations (mining and transformation for production of network equipment)	• Supplier assessment (Demands on avoiding use of hazardous chemicals, on-site audits) • Procurement of eco-labelled products

7.1.4 Sustainable Sourcing

Increasing global warming has put demands on organization to curb their emissions to limit the climate change to 1.5º C. To meet this requirement, organizations have set scientifically verified climate action goals and targets to track the progress in reducing the emissions as explained in the section 7.1.1.

Reducing scope 1 and scope 2 emissions are under the control of an organization, however, to reduce scope 3 emissions, organizations must engage with their supply base and achieve the reductions collaboratively. An entire industry achieves net-zero emissions only when each actor in the industry works towards the reduction of all the three scopes of emissions. The telecommunications industry being a service-based industry, it possesses most of its associated emissions in its supply chain as indirect emissions rather than the place from where the service is offered (Horvath, 1999). TCOs being the focal companies, they are questioned by their customers regarding these hazards. This implies that case company´s (Volvo Group) evaluation of these telecommunication service providers needs to consider aspects on how they manage the sustainability risks in their supply chain. This section investigates the climate risks within the supply chain of the telecommunication service providers, whereas the social risks within their supply chain are discussed in section 7.1.6.

The telecommunication industry supply chain is very diverse in nature due to its complex nature. For example, Telia, as a telecom service provider, requires equipment for the network infrastructure and hence their tier 1 suppliers being equipment providers such as base stations, towers, antennas, software, other electronic equipment etc and the tier 2 suppliers are the manufacturers of the sub-assemblies associated with the telecom equipment. The indirect emissions in the telecommunications industry are also referred to as embodied emissions that originate from the materials used, manufacturing and transportation of the electrical and electronic equipment sourced by the telecommunication operators. This telecommunication network equipment comprises of semiconductors that in turn require usage of certain toxic chemicals such as fluorine that are not environment friendly.

Base stations are network equipment used in providing mobile telephony services and their production accounts to 91% of its carbon footprint, out of which about 41% is associated with the extraction of raw materials and its transformation for the production purpose (Madon, 2021). The rest of the emissions of the base stations are from its operation phase because of high energy consumption as explained in section 7.1.2. These findings on base stations are similar to other network equipment. Other sources of emissions in the supply chain of these telecommunication operators are from the external contractors hired by them to manage the construction, maintenance and repair activities related to their network infrastructure. There are various tools and methods used by the TCOs for sustainable supplier selection and track, monitor, and engage with them in sustainability work to curb the supply chain emissions. Use of supplier code of conduct, supplier assessment, contract agreements, onsite audits are the tools used to put forth demand on suppliers and engage in sustainable supply chain management.

All three suppliers have set demands to suppliers at a broader level through their supplier code of conduct. The supplier code of conduct focuses on environmental and social sustainability aspects. A supplier code of conduct helps telecom operators to convey their goals, values and expectations to the stakeholders in an official format. The code of conduct deters the suppliers from irresponsible practices and promotes honest ethical business practices. One of the demands that all three TCOs interviewed set through their supplier code of conduct is to have climate action targets that are verified by SBTIs.

AT&T supports their suppliers in achieving this broad goal by providing training and grants in necessary cases. There are other demands set in the supplier code of conduct that ensure minimal supplier performance in several areas in accordance with the telecommunications industry. However, these are very broad goals and the TCOs need to implement supplier assessment process and evaluation criteria for each sourcing project.

The focal companies (TCOs) initiate two strategies in their sustainability agenda which are similar to the strategies proposed by Seuring and Müller (2008) in their SSCM framework. Figure 7.3 depicts the supplier's sustainability strategies in relation to the SSCM framework. All three suppliers, by using supplier assessment questionnaires for evaluation and onsite audits in their tendering process identify the sustainability risks to increase the supplier´s performance, which is the first strategy in the SSCM framework. The second strategy that all three suppliers follow is establishing a supplier code of conduct and using it as one of the communication channels to engage with suppliers in sustainable development and providing training to suppliers in the sustainability aspects. These two SSCM strategies are governed by the supplier management system to ensure responsible sourcing.

There are different platforms, questionnaires, and foundations on which the three suppliers perform their supplier assessment and evaluation. Tele2 uses a platform named Eco-Vadis which provides sustainability evaluation criteria to various industries including the network and telecommunications industry. Like Tele2, AT&T make use of a sustainability questionnaire provided by the telecommunications industry association (TIA) known as the TIA Sustainability Assessor tool. They also make use of an onboarding questionnaire with suppliers, to map the risks with each supplier helping them visualize the risks and its mitigation plan. Before the supplier onboarding, the suppliers are scanned against a restricted party listed by worldwide government, to not to develop any business relationships with such suppliers. This is done as part of their due diligent sourcing. Telia for their supplier assessment, have developed an evaluation model to assess the climate maturity of their suppliers and identify the potential risks. Thus, it is evident that all three suppliers assess and evaluate their suppliers.

From the interviews and the literature review, it can be summarized that the supplier assessment and evaluation investigate three major themes of sustainability issues as follows: -

- Sustainability issues related to the materials used and the production process (embodied emissions) of the network equipment. Emissions from the construction, maintenance, and repair operations in the case of external contractors. Eco-labelling is a certification from the EU union ensuring that the product is manufactured in an environmentally responsible way. During the tendering process by demanding such recognized labelling certifications or ensuring the fulfilment of requirements necessary to achieve these certifications, TCOs can responsibly source, (EU GPP Criteria, 2012).

In addition to assessing the product, the production process and operations at the supplier sites need to be assessed. This can be achieved by demanding data from the suppliers on the use of environmental management systems in their operations, which could be used to evaluate the sustainability maturity of the suppliers. The use of environmental management systems by equipment suppliers provides them guidance on the materials used to manufacture the product, thus prohibiting them from the use of hazardous and toxic substances. Tele2 constantly pressurize their suppliers towards reduced raw materials consumption in the manufacturing of network equipment, which emphasizes the risks posed by it.

- Network equipment design and its energy efficiency, which plays a major role in reduction of scope 1 and scope 2 emissions during their operations phase – Sourcing of eco-labelled products or network equipment that fulfills such labelling requirements ensures high quality of the product that in-turn reduces the energy consumption during its operations. Thus, according to Sfez (2021), TCOs can explicitly use energy consumption as one of the evaluation criteria in the sourcing projects. By demanding such requirements from suppliers and collaborating with them has helped AT&T in designing and developing energy efficient network equipment that is now deployed in their network operations.
- Supplier´s openness to collaborate with regards to waste management of the network equipment at their end-of-life – This theme of supplier assessment evaluates the supplier's preparedness to collaborate in dealing with waste management of network equipment by recollection and recycling. Further, eco-design can be used as an evaluation criterion to assess the maturity of the suppliers from the resource consumption and the circularity perspective (Badri Ahmadi et al., 2016).

Apart from supplier assessment and evaluation through questionnaires, TCOs emphasized the importance of onsite audits. Audits provide complete transparency with the suppliers' operations and help to close the gaps within non-conformities. The suppliers use various criteria to determine if an onsite audit is necessary. For instance, Tele2´s onsite audits are majorly dependent on the degree of their supplier alignment to the supplier code of conduct. Other factors on which Tele2 base their audit decisions are geographical location of the supplier, the type of product or service sourced and the supplier's performance in supplier assessment. The tier-1 and tier-2 suppliers in Tele2´s supply chain are network equipment manufacturers and component producers for this equipment respectively. The probability of tier-1 and especially tier-2 suppliers located in low-cost labor countries is high. Less stringent legislation policies with regards to climate impact in these countries contribute towards most of the climate risks associated with the suppliers located in such countries. Telia confirmed the presence of their supply base in such countries such as China, however only risks associated with social sustainability were emphasized.

AT&T and Telia conduct onsite audits on their high-risk supplier, for which they collaborate with a third-party organization called “Joint Audit Corporation (JAC)”. JAC is an association of several TCOs with a vision to develop sustainability implementation across the manufacturing sites of the suppliers involved in the information and communication technology (ICT) industry. Apart from onsite audits, JAC provides corrective action plans and improvement roadmaps and this work on sustainability implementation is not just limited to tier-1 suppliers, but also to tier-2 suppliers and beyond. Risks associated with environmental sustainability is one of the most frequent areas in which suppliers are demanded with corrective actions and follow-ups. In contrast to AT&T and Telia, Tele2 do not collaborate with other audit organizations such as JAC. This is because Tele2 believes that developing audit skills needs to be a core skill that any organization needs to develop as a way forward to achieve sustainable growth. Tele2 believes that the major telecommunication suppliers are audited by JAC and thus, they conduct audits by themselves on their critical suppliers.

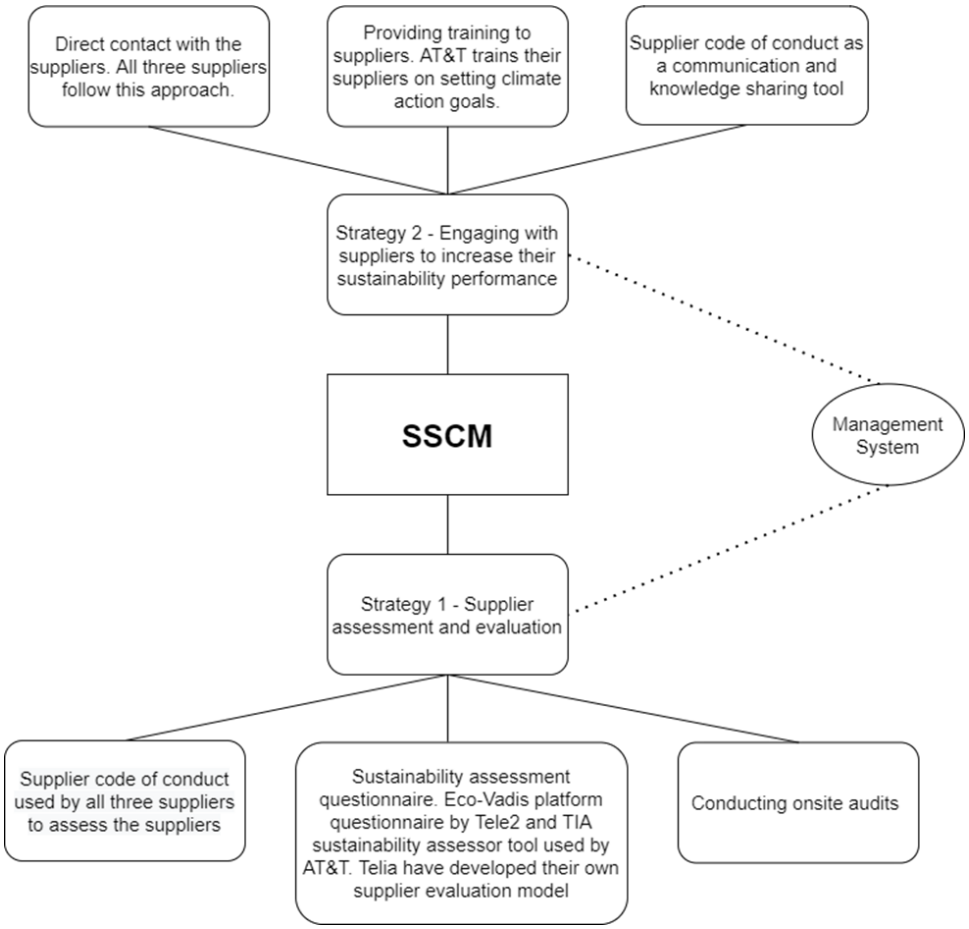

Figure 7-3 SCM framework Source - Altuntas and Turker (2012) adapted from the study of Seuring and Müller (2008).

The second strategy proposed in the SSCM framework is to communicate and engage with suppliers in sustainability implementation, which is complementary to the first strategy that identifies potential risks

amongst the suppliers. There are various ways in which the three suppliers put forth the second strategy into action. Being in direct contact with the suppliers through open communication channels, supplier code of conduct, contract agreements & governance, and providing training to the suppliers are the approaches used by the three suppliers. Tele2 has established an open communication channel with its top suppliers by spend to collaborate with them and communicate their sustainability goals and initiatives to improve the supply base´s sustainability performance.

An analysis by Telia on their scope 3 emissions revealed that their top 100 suppliers accounted for 80% of scope 3 emissions. Thus, Telia similar to Tele2 are in direct contact with these suppliers to collaborate and train these suppliers on reducing their emissions. Supplier code of conduct, apart from setting demands, it also acts as a tool to share the knowledge on sustainability risks to the suppliers by the focal companies. AT&T makes use of the supplier code of conduct as a tool to promote best practices in its supply chain with regards to resource use, climate impact, water use, human rights, waste management and energy use. This implies that supplier code of conduct is not just to set demands to suppliers, but also a way to engage with suppliers in promoting sustainable development. Training suppliers is also an important aspect of engaging with suppliers, AT&T provides such training on suppliers helping them setting climate action goals and reducing their emissions.

The risks originating from the supply chain of TCOs, and various ways used to mitigate these risks are presented in this section. Three major themes of supplier assessments that are critical to manage the environmental risks in the TCOs supply chain are discussed. Based on these aspects, it is important for the case company to investigate the presence of these risks in the TCOs supply chain, which in-turn is an extended supply chain of the case company. Mitigation strategies discussed in this section help the case company in evaluating the maturity of a telecommunication provider in handling the sustainable supply chain management risks. This is critical because the sustainability risks are more likely to originate from indirect supplier relationships rather than the direct one´s, (Miemczyk et al., 2012). The major focus of this section has been on network equipment providers and its components manufacturers, as most of the risks associated with external contractors are with social sustainability rather than environmental sustainability. A reason for this may be that, as external contractors' activities are close to the operations of a TCO, they are less prone to climate risks. However, a detailed investigation assessing the climate risks of the external contractors needs to be carried out.

Table 7-6 Supply chain risks and mitigation in N&T

Sustainable Sourcing Approaches		**Description**
	Supplier Evaluation and Assessment	• Assessing climate maturity of suppliers to identify potential risks • Sustainability questionnaires

Supplier Selection		• Use of environmental management systems • Energy efficiency of the network equipment • Openness to collaboration • Certifications (Eco-Label)
	Onsite Supplier Audits	• Visibility in supplier´s operations • Audits provide corrective action plans for suppliers in case of non-compliance
Supplier Communication	Supplier Code of Conduct	• Acts as a communication tool to promote knowledge on the best practices and sustainability strategies
	Contract Agreements and Governance	• Regular follow-ups with suppliers based on sustainability performance
	Training Suppliers	• Providing help with setting climate action goals • Helping suppliers to reduce emissions
	Open Communication with Suppliers	• Close collaboration with top suppliers to promote sustainable development

7.1.5 Circular Economy

Due to the increasing demand within the N&T industry, there is a boost in offering newer services and products with technological innovation at lower prices. As a result of the pace of innovation, the equipment is discarded even before its end of life creating huge amounts of e-waste. This approach of take-make-dispose is known as the linear economy model. This approach puts pressure on the existing resources and is unsustainable. In order to avoid the stress on the earth's resources a circular economy model with an approach of closing the loop of resources should be practiced. Circular economy involves reusing the material in the successive production cycle to reduce the waste and pollution associated with it.

The telecommunication service providers have a huge amount of electrical and electronic equipment deployed in their operations. If care is not taken to manage these equipment at their end-of-life, they eventually end up in landfills or become disposed of in a way harmful to the environment. This waste

management risk further increases if there are hazardous substances used in manufacturing these equipment. Apart from the waste generated from the network equipment, there is waste present in the telecommunications industry because of the intense construction and maintenance activities involved. Usually, the network infrastructure construction and maintenance activities are taken care of by external contractors. These external contractors put a lot of waste into the ecosystem, if not governed by the focal TCOs. Thus, it is important for the TCOs to manage the waste in their operations and regulate the suppliers and external contractors for the same.

The network equipment made up of electrical and electronic components consumes a lot of raw materials in their manufacturing. The manufacturing of base stations is estimated to contribute to 91 % of its entire life-cycle emissions, out of which 41 % is associated with raw materials extraction and transformation. In addition to the waste generated by the network equipment, the construction activities consume huge amounts of unsustainable raw materials such as steel and concrete. The production and refining of these materials has a negative impact on the environment causing air pollution, solid acidification, and water pollution. The TCOs´ operations involve plastic waste in the form of product packaging and sim cards necessary for mobile telephony services. In order to manage this waste, the TCO´s and their suppliers need to collaborate to jointly work on circular business models with respect to the network equipment. Firstly, the TCOs need to ensure a reduced consumption of hardware components by moving towards hardware virtualization, and reuse & recycling of the network equipment. The TCOs need to follow the best practices of waste management like the waste hierarchy framework recommended by Canfora et al. (2020). All three TCOs work towards reducing their hardware consumption, then reuse and recycling, and responsible disposal only as the last option. Thus, it is critical for the TCOs to reduce the amount of hardware that they consume and to consider the resource consumption by their suppliers in manufacturing the network equipment or construction materials and lastly, to set up robust waste management principles.

To be more energy efficient, TCOs are undergoing the phase of network modernization. However, there is a huge hindrance for this exercise due to the responsibility of decommissioning the old legacy hardware. The task of decommissioning of the old equipment has a limiting factor, for example, as the impregnated telephone poles cannot be reused or recycled. Also, the treatment of these old equipment incurs emissions from transport and logistics. The recycling of these equipment usually occurs at the recycling vendor sites that might be far from where the equipment is deployed. The transportation to the recycling vendor sites has emissions associated with it. Another approach can be to responsibly dispose of the equipment to landfills. However, carbonaceous chemicals such as creosote present in these telephone poles cause health hazards.

According to the interviews and the literature review, the TCOs use the following approaches to reduce their hardware consumption: -

- **Hardware Virtualization** – In this approach, TCOs replace the functionality of certain hardware equipment with a software function. Scaling such projects to a broader range of

hardware equipment across all their operational sites will enable significant reduction in resource consumption. It is important to note that the hardware equipment which is decommissioned needs to be taken care of in a responsible way. All the TCOs in this study are actively engaged in these projects.

- **Infrastructure Sharing** – TCO operators should collaborate and consider the opportunity to reduce waste by reducing network equipment. In this approach, when a TCO wants to expand their business and operations in a different region, instead of setting up a new network infrastructure, they could share the existing ones with other TCOs. Technological advancements in industry have made it possible to share the network infrastructure without any loss in the service quality offered. For instance, Tele2 shares half of its 3G network infrastructure with their competitors Telia and half of the 2G, 4G and 5G network infrastructure with Telenor. Tele2 emphasizes that infrastructure sharing not only has a positive impact on the environment, but also contributes to operational cost savings and unnecessary duplication of resources.
- **Reuse and Recycle** – The consumption of resources in a TCO´s operations can be reduced by increasingly reusing and recycling of the hardware components and raw materials in the case of construction. The waste hierarchy followed by all the three TCOs in the study make use of reusing and recycling. To set up the reuse and recycling of the network equipment, it is necessary for the suppliers and the TCOs to collaborate. The literature review suggests that a way to ensure such collaboration with the equipment suppliers is by setting up demands and evaluating their openness to collaborate before supplier selection. From an economic perspective, reusing and recycling is beneficial as well. However, a major challenge faced in reusing and recycling of network equipment is the use of hazardous substances as noted in section 7.1.3. These hazardous substances in the network equipment can make it impossible to reuse or recycle a product.
- **Plastic Waste Reduction** – Firstly, the use of plastic in product packaging is eliminated by pressurizing suppliers to replace plastic with other recyclable sustainable materials. TCOs can also adopt more sustainable practices by offering e-sim cards as this will altogether help to cut down on the emissions associated with manufacturing and transport and reduce the use of plastic. The e-sim technology is still in the development stages and none of the TCOs interviewed in the study have deployed it yet. Tele2 foresees the benefits of circularity like resource conservation, cost savings and lower carbon footprint. This made them innovate within their product offering by cutting down the size of sim cards to half.

Further, reducing the usage of resources and raw materials in the network equipment could be achieved by recycling and by demanding suppliers to reduce the resource consumption. In the literature review, eco-design is one of the sustainability criteria that is emphasized. With the use of this sustainability

criteria, TCOs can ensure that network equipment is designed in such a way that they consume a minimal amount of resources and that they are suitable for recycling. Telia, apart from demanding the eco-design criteria from their equipment suppliers, provide training to their employees on it. Similarly, AT&T have eco-design as one of the evaluation parameters in the TIA sustainability assessor tool that they use.

The use of environmental management systems such as an asset management system is an important aspect of waste management. Effective usage of these management systems can benefit the TCOs in terms of equipment service-life extension and reduction in waste generated from the operations, (Canfora et al., 2020). The key metrics that the TCOs use to track their progress in managing waste are the share of operations that measure and monitor waste, the amount of waste generated, and the amount of waste reused, recycled and sent to landfills. The TCOs collaborate with external partners that are specialists in recycling and waste management of network equipment and construction wastes. Telia collaborates with Stena Recycling, who provide them with recycling and waste management services with respect to construction waste. Similarly, AT&T contracts R2 certified vendors for recycling and management of various wastes from their operations. R2 stands for "Responsible Recycling" awarded to recycling vendors, whose operations are verified to be sustainable. This standard of certification is specifically created to regulate the recycling operators in the electronics recycling industry. Table 7.7 summarizes the various waste management approaches within N&T.

Table 7-7 Waste management in N&T

Waste Generation and Resource Consumption	**Mitigation**
Electrical and electronic equipment	• Circular business models • Hardware virtualization • Collaboration for waste management • Infrastructure sharing • Effective usage of management systems
Hazardous chemicals	• Responsible disposal causing no damage to the environment
Network construction, maintenance, and repair activities	• Effective usage of management systems
Resource consumption by suppliers	• Regulate suppliers and contractors on resource consumption • Eco-Design

SIM cards and their packaging	• Collaborating with suppliers to reduce the amount of plastic consumed • E-sim cards

7.1.6 Social Sustainability risks

The work on sustainable development should consider the triple bottom line (TBL) perspective. According to this perspective, it is not sufficient for organizations to consider just economic and environmental performance, the social sustainability risks involved both in their operations and the supply chain needs to be considered as well. Globalization of industries has made the supply chains complex, causing lack of visibility for the focal companies and the lack of transparency in the supply chain is ever increasing. Only the social sustainability risks related to human health, labor work conditions, and human rights are discussed in this study. Other social sustainability risks involved such as lack of diversity and inclusion, and business ethics are deemed out of scope for this study.

A review of the literature showed that the major sustainability risks originate from the supply chains. The working conditions of employees has been identified as one of the major supply chain social sustainability risks in the telecommunications industry. About more than a 75% of these risks are estimated to originate from actors outside the focal company´s organization, (Valinejad & Rahmani, 2018). This working condition of employees is not just a risk within the telecommunication industry supply chain, but also is a risk within a TCO´s operations. A reason for labor working conditions as one of the major social sustainability risks can be attributed to the large amount of labor force in the telecommunications industry. The external contractors providing the construction services and network equipment suppliers have a huge labor force in their operations. Also, there is a huge amount of labor in the TCO´s operations, especially with respect to the maintenance and repair activities. Thus, TCOs who are part of these complex multi-tier supply chains must consider aspects regarding work safety and labor health conditions in their supplier selection decisions. Apart from the human health risks in the supply chain, there are certain human health hazards associated with the use of hazardous chemicals and substances in the network equipment that are deployed at a TCO´s operational site. Further, maintenance and repair of this network hardware might require the use of such hazardous substances, which may bring a TCO´s labor in close proximity to these hazardous substances. Detailed discussions on the risks associated with the hazardous substances involved in a TCO´s operations are presented in section 7.1.3.

The electro-magnetic field (EMF) radiations involved in a TCO´s operations to provide mobile telephony services, it present certain human health hazards to people in the surrounding environment when exceeding the threshold limit. This human health risk involves EMF interfering with the human body to cause damage to human and immune systems. This risk becomes more probable when the telecommunication towers of the TCO´s are located in residential regions. According to Tele2, there

are risks associated with human complications due to interference with EMF were confirmed. To mitigate this risk, Tele2 follows norms provided by the world health organization (WHO). The literature suggests that following such norms from international organizations and being EMF compliant with no risks to human exposure is a way to deal with this risk, (Canfora et al., 2020)

The TCOs operations pose social sustainability risks such as unsafe work conditions, labor safety, child labor, and forced labor. To mitigate these risks, Tele2 has developed an Occupational Health and Safety Management System and an employee code of conduct providing their employees training and guidance on their rights as Tele2´s employees. Modern slavery is one of the potential labor rights risks identified by AT&T. AT&T has a human rights committee within their organization to monitor and take care of the implementation of their human rights policy. Similar to Tele2, AT&T has an Occupational Health and Safety Management System. As AT&T believes these social sustainability risks to be critical, they provide training to their employees based on each employee´s job responsibility and potential risks that they are prone to. Further, AT&T has a business handbook in place that provides information to their employees on the best practices of mitigating social sustainability risks. Lastly, Tele2 emphasizes that these risks are not observed to a greater extent in their operations as the Swedish labor and human rights law has stringent requirements regarding the employee work condition and rights. This implies that these social sustainability risks might probably be critical when sourcing the telecommunication service from a TCO present in regions with less stringent regulatory laws.

The social sustainability risks are not just associated with a TCO´s operations, rather more prominently present in the telecommunications supply chain. A study conducted by Chen et al. (2021) highlighted unhealthy work conditions that threaten the human health as one of the critical risks in a TCO´s supply chain. The adverse effects of these sustainability risks were detailed during the interviews with Telia. They note that most of the social sustainability risks such as child and forced labor are associated with the extraction of metals and materials that are used in the products that they source. Although they have not noticed any child labor violations, they suspected the presence of forced labor activities that affected the people from an indigenous community of China. Further, in the interviews they emphasized that these risks were noticed in the further upstream of their supply chain involving lower tier suppliers from low labor cost countries posing high sustainability risks. Owing to the complexity of telecommunications supply chain, lower tier suppliers located in farther countries induce the risk of low visibility and transparency. This lack of visibility of lower-tier suppliers makes it impossible for TCOs to investigate the sustainability risks present. With regards to this, Telia noted nearshoring or reshoring as one of the solutions to manage these risks, however, other trade-offs need to be considered in such decisions. Telia shared their views with regards to risks that they foresee from their external contractors responsible for their construction activities. One such risk was that the construction and maintenance activities are often related to mobile towers involving working at higher altitudes, which creates unsafe work conditions for the laborers

In order to mitigate these risks in the supply chain, Tele2 and AT&T who make use of sustainability questionnaires from Eco-Vadis and TIA respectively, noted that these assessment tools include evaluation of the risks with regards to social sustainability. Tele2´s Eco-Vadis sustainability questionnaire requires suppliers to provide documentation wherever necessary as a confirmation to their responses. Further, AT&T as part of their due diligent sourcing scan their suppliers against a restricted supplier list before awarding them a contract. AT&T also uses a tool called "Mobile Workers Survey" which they send out surveys to the employees and laborers of their supplier companies to increase the visibility of their work conditions and to identify any risks if present. Likewise, Telia makes use of self-assessment questionnaires to put forth criteria on the social sustainability risks. Based on the responses, Telia categorizes the risks and mitigates them. Apart from the questionnaires, all TCOs interviewed in the study make use of supplier code of conduct and onsite audits to handle the discussed risks as noted in section 7.1.4. Further, the social sustainability risks associated with the external contractors are handled by Telia through a catalog document. The catalog document comprises the work safety risks of laborers for each contractor and the mitigations strategies of these contractors are discussed in the governance meetings.

Lastly, use of conflict minerals in the hardware equipment sourced by the TCOs is a risk within their supply chain. The major conflict minerals are tin, tantalum, tungsten, and gold that are extensively mined from countries adjoining the Democratic Republic of Congo (DRC), which are recognized as conflict zones. The TCOs sourcing hardware equipment that comprise of the metals and minerals mined in these regions will indirectly support the armed groups, abuse of human rights and environmental degradation. All three TCOs from the study handle the risks associated with conflict minerals through their supplier code of conduct, directives and policies, and by demanding certificates that confirm responsible sourcing with respect to conflict minerals. Telia recently updated their supplier code of conduct and made stringent requirements on conflict minerals which led to a few supplier non-conformities and deviations. These supplier non-conformities were resolved through supplier engagement and collaborations. Similarly, AT&T has a strong demand for conflict minerals which allows them to terminate the contract in case of non-compliance and audit the suspected suppliers.

In general, the N&T industry might induce stress on the laborers to facilitate the telecommunication services. To tackle these risks, most of the TCOs in the N&T industry seem to be serious in mitigating such risks that may be present. Thus, it is highly important for the case company to assess the TCOs and their mitigation of sustainable supply chain risks to make responsible sourcing decisions. Table 7.8 summarizes the social sustainability risks in the N&T industry and their mitigation.

Table 7-8 Social Sustainability risks and mitigating in N&T

	Risks	**Mitigation**
Operations	Electro-magnetic radiation	EMF compliant
	Maintenance and repair activities	Safety training

	Less stringent labor laws	Global legislatives, Management systems to monitor and mitigate the risks, employee code of conduct
Supply chain	Multi-tier suppliers	On-site audits, code of conduct, Management system to monitor and mitigate the risks, sustainability questionnaire,
	Lack of visibility	Near shoring
	Less stringent labor laws	Global legislatives
	Conflict Minerals	OECD compliance

7.2 How Can the Case Company Improve its Sustainable Sourcing Strategies

Sustainable procurement is of great importance to the case company and the projects and initiatives towards responsible sourcing are emphasized more than ever. The case company´s sustainable sourcing initiatives are not just limited to direct procurement, but also to procurement of indirect products and services. Sourcing of digital products and services is a part of the indirect procurement at the case company within which the network and telecommunication services segment falls. The services sourced within the digital purchasing are not as tangible as those related to direct procurement, which emphasizes the relative differences between their procurement. This difference in sourcing implies that sustainable procurement strategies need to be carefully designed and developed on a segment-by-segment basis. Apart from the top management, the buyers and procurement professionals are constantly investigating how they can develop sustainable supply chain management within their portfolio. The current sustainable procurement strategies include the use of supplier code of conduct, self-assessment questionnaires and onsite audits. However, more sustainable procurement strategies need to be explored owing to the differences in the industries from which the products and services are sourced.

The case company makes use of the supplier code of conduct to ensure certain basic values are followed by the suppliers. This in turn gives the case company an opportunity to ensure that these business partners share the same values, responsibility and goals as that of the case company. Ensuring the suppliers alignment and compliance with the code of conduct contributes to a minimal performance on sustainability. The reason behind this minimal performance could be that the critical risks might go unidentified when certain basic values are to be adhered to.

The strategic use of the supplier code of conduct is perceived as a tool of communication by which the case company conveys the level of expectations towards the suppliers´ sustainability practices. The supplier code of conduct is based on several broad frameworks such as UN Guiding Principles of Business and Human Rights and International Labor Organization (ILO). Since the supplier code of conduct is based on these broader frameworks, it just acts as a guiding principle on various potential

sustainability risks and understanding these various risks is helpful for further development of the responsible sourcing practices.

The supplier code of conduct demands sustainable practices from the suppliers of all three dimensions of the triple bottom line. These demands put forth ensure the sustainable practices of suppliers at a broader level such as the use of environmental management systems, policies for business ethics and human rights violation. However, specific sustainability risks within the supplier´s operations and the supplier´s supply chain are not identified and prioritized for mitigation according to the products or services that they provide. Further, the supplier code of conduct ensures sustainable practices mostly within the direct relationships between the suppliers and the case company. Most of the sustainability risks within the extended supply chain of the case company that includes multiple tiers of suppliers are not identified and mitigated. This problem of not identifying the sustainability risks within the extended supply chain aggravates in the case of services sourcing such as N&T services. The reason for this is because most of the sustainability risks in the service sector originate from lower-tier suppliers. Hence, when sourcing services it is particularly important to consider the sustainability risks within the extended supply chain.

In addition to the supplier code of conduct, a self-assessment questionnaire (SAQ) is another tool used to ensure responsible sourcing by the case company. It is mandatory for the suppliers to answer the SAQ before being awarded a contract and the SAQ is valid for three years. The SAQ is developed by "Drive Sustainability", a partnership organization between the top automotive industry OEMs. This indicates a significant alignment of the risks being assessed in the SAQ towards suppliers within the automotive industry. Since other OEMs have similar demand through the SAQ, it helps the suppliers to create a positive impression for their brand in the market and reduce the time it takes to answer the questions due to a single platform shared by all other automotive OEMs (for which the supplier is a vendor or will be in the near future). Thus, the SAQ mostly assesses the risks related to the direct purchases of the case company and using this SAQ for sourcing of indirect products and services would be like a "one solution for all" scenario. However, such solutions are not sufficient, especially when assessing the sustainability performance of the suppliers.

The documents provided by the suppliers as part of their responses to the SAQ are checked by an organization called NQC. However, NQC just evaluates the suppliers' responses and the ultimate decision whether the supplier is qualified or not lies with the buying company. Based on the NQC evaluation, Volvo Group scores the supplier and the minimum criteria to be qualified is a score of 60% in the SAQ. Further, certain risks within the SAQ are categorized as "stopping parameters" by the case company, intending a mandatory fulfilment of mitigating those risks to be considered as a potential supplier. Although there are certain stopping parameters present, they do not address all the specific risks within the supplier´s operations and their supply chain. Thus, the case company needs to take up projects and initiatives in identifying the best practices of sustainable sourcing and must implement them on a segment-by-segment basis.

In efforts towards balancing the social, environmental components in the business along with the economic components to add value for the shareholders, Volvo Group conducts onsite audits on their suppliers to assess the risks and to validate their compliance. During the audit a thorough inspection is done on the documents, procedure, work conditions, and operations. The suppliers are assessed in terms of “none, low, high and critical” risks observed. Based on the results a corrective action plan is drawn up in case of non-compliance. Performing these onsite audits consumes immense resources as it involves travelling to the supplier´s site and assessing their operations management systems and policies. Geographical location and supplier product offerings are the two major reasons to assess the supplier's compliance, because the sustainability risks are a major concern because of less stringent laws in some regions. Onsite audits are a resource consuming process and are limited to suppliers located in high and extreme risk countries identified by the case company. Limiting the audits to just these countries limit the opportunity to identify potential sustainability risks within the suppliers located in countries other than those associated with high and extreme risk. The aim of the audits is not limited to compliance but also continuous improvement and sustainable change, which provides more transparency into the supplier operation

The current approaches of responsible sourcing at the case company are too focused on automotive suppliers and are relevant to those who provide automotive components and services to the case company. This does not imply that the present approaches are not important for sourcing of indirect products and services, it just implies that these approaches need to be considered as guidance in each sourcing segment and project taken up. Further, while sourcing services, there is a high possibility of sustainability risks originating from the lower tier suppliers and hence, it is important to investigate the multi-tier supply chain for responsible sourcing of services. The guidance from the present sustainable procurement strategies needs to be used in identifying and understanding the supply chain sustainability risks within the industry of the sourced indirect product or service. In this study as the focus is on sourcing of network and telecommunication services, the case company must make use of the discussions in section 7.1 to put forth specific questions for assessing and evaluating suppliers in a sourcing project. Because none of the measures are specific to the telecom industry, a new tool should be established.

Volvo Group sends out RFP to request commercial, technical, and product-related information from their suppliers, which are communicated in the form of functional and nonfunctional requirements. The RFP is sent out to a few potential suppliers, who are shortlisted based on their responses and then a decision for selection is made by the case company. These requirements in the RFP are very specific, however in some cases in order to take advantage of the expertise of suppliers within their industry, open and general questions are asked. This will make the suppliers spur their creativity to propose the best solution based on their expertise and best in industry solutions. Thus, it is strategically the best option for demanding solutions on sustainability requirements in the RFP. Hence, it is important for the case company to understand the risks present in the telecommunications industry and its mitigation,

based on which specific questions can be formulated and demanded in the RFP. Table 7.9 summarizes the present sustainable sourcing strategies at the case company and suggests how it could be developed.

Table 7-9 Sustainable Procurement Strategies at the Case Company

Approach	Present / Recommended	Description
Supplier Code of Conduct	Present	Ensures basic values, Demands sustainable practices at a broader level, Risk management mostly at the tier-1 supplier level, Acts as a guiding principle on various potential sustainability risks.
Self-Assessment Questionnaire	Present	Specific to automotive purchasing, Lacks investigating the sustainability risks specific to a supplier industry.
Onsite Audits	Present	Resource consuming,
Telecommunications Sustainability Questionnaire in RFP	Recommended	Specific questionnaire and demands put forth based on the supply chain sustainability risks within the industry of the sourced indirect product or service.

7.3 How Can the Case Company Improve its Supplier Governance Model

RFP is a tool to put forth the requirements and governance is a tool to follow-up on the progress of the agreed upon deliverables. Volvo has defined and implemented a clear and unambiguous governance structure. The governance model is multi-tiered with strategic, management and operational levels which helps with decision making as well as providing a clear pathway for escalation.

It is not enough just to question the suppliers about specific risks in their operations and the supply chain, it is equally important to regularly follow-up. This regular follow-up, also referred to as governance involves evaluating the progress of the supplier´s on the agreed requirements when the contract is awarded. Supplier governance is inherent to contract and vendor management in the case company and thus, it is relatively easier to follow-up with respect to sustainability as the governance process is already set-up. The case company re-shored the tactical and strategic level of supplier governance from a third-party business partner a couple of years ago, which signifies its importance. At the tactical level of governance, various aspects on the sourced product or service and potential improvements to align to each other´s business goals are discussed. Thus, it is strategically important to introduce discussions at this level on sustainability risk management based on the supplier´s responses to the sustainability questionnaire in the RFP as discussed in section 7.2. Further, the case company makes use of a supplier evaluation model for evaluating the service quality, similar to which a sustainability evaluation model could be set up. The sustainability evaluation model can comprise of various parameters and metrics associated to the RFP response of the supplier. Based on this

sustainability evaluation, the suppliers could be awarded a score and an action plan can be set up if the supplier is performing low on any of the parameters. The strategic level of governance involves discussions on supplier relations and business goal alignment by the top-level management of both parties. It would be important to dedicate some time for discussions on sustainable sourcing at a broader level in the discussions at the strategic level as well. To conclude, it is important to understand the significance of discussing sustainability risk management in supplier governance meetings as a powerful way to ensure responsible sourcing.

7.4 Best Practices from Other Customer Relationships

The amount of technological development in the telecommunication industry and the pace with which the growth is taking place offers immense potential to improve sustainability performance in other industry sectors such as transportation, in which the case company is a major player. However, there is a huge amount of sustainability risks in the operations and the supply chain of the telecommunications industry as detailed in section 7.1. The TCOs, who provide the telecommunication services are the focal companies of the industry and thus, all the sustainability demands on mitigating the risks and improving the performance are directed to these focal companies. Although there are huge benefits in improving the sustainability performance of one´s own operations by collaborating with the TCOs, there are inherent sustainability risks present within the telecommunications industry itself. Hence, it is critical for the case company to work with the TCOs on both to improve their sustainability performance and demand mitigation of the sustainability risks at the same time. This section discusses the best practices followed by other customers of the TCOs (Telia and AT&T) interviewed in this study and investigates how the case company can adapt its supplier relationship management (SRM) and supplier selection processes while sourcing the telecommunications services.

Both Telia´s and AT&T´s customers demand sustainability performance and considers it in their supplier selection processes. These customers put forth their sustainability demands through various channels such as surveys, inquiries, and self-assessment questionnaires that includes both generalist questions and more mature questions on the sustainability risks associated with telecommunications industry. In addition to these, few of Telia´s customers include questions on sustainability related risks in their RFP and the contractual agreements. Ensuring sustainability questionnaire as part of the RFP emphasizes the importance to consider sustainability as one of the criteria, which ensures that sourcing decisions are made considering all three aspects of TBL. Further, including the sustainability performance metrics in contractual agreements as a next step towards sustainable procurement ensures the validity and authenticity of supplier´s responses and their initiatives towards sustainable development. Based on these various practices, the case company needs to consider sustainability demands as part of their RFP and contractual agreements to follow-up on supplier´s sustainability performance over the contract years.

It is not enough just to put forth sustainability demands, collaborating with the TCOs and working together on assessing the sustainability risks and their mitigation through collaborative projects is important. According to Telia, the amount of collaboration and involvement by its customers varies. Their customer base has a wide range with both less mature and highly mature customers and the way these customers work with Telia is driven by their level of maturity. Customers with low maturity level just follow a tick-box approach method, i.e they put forth sustainability demands through questionnaires as a formality with no intent of working towards sustainable development. On the other hand, Telia has highly matured customers who put forth demands, evaluate the responses of the sustainability questionnaires, and work closely together with Telia on improving the sustainability in the industry. Telia, being a leader in their industry, are relatively more powerful than their customers in the buyer-supplier relationship. Touboulic et al. (2014) notes that in such a power imbalance situation, the knowledge sharing between the buyer (Telia´s customer) and supplier (Telia) is impeded hindering the sustainability initiatives. To overcome the challenges of such a power imbalance situation, it is important for the two parties to collaborate on sustainability initiatives. This is evident in one such project where Telia collaborated with their customers in assisting them with analyzing the critical sustainability risks within the telecommunications industry and developing a sustainability questionnaire.

The services offered by the TCOs are similar to each other. However, Telia believes that collaborating with the customers on improving the sustainability performance in their operations has provided them with a competitive edge over their competitors. This is observed in the form of price premiums as a result of their sustainability performance. Likewise, the case company can offer price discounts to their telecommunication service providers and ensure collaboration for sustainable development. This makes it a win-win situation for all the parties involved, including the environment. This implies mitigation of sustainability risks in the customer´s supply chain and improved business for Telia.

The other face of the collaboration projects and initiatives between the TCOs and their customers is investigating on how the telecommunication technological development is beneficial for improving the sustainability performance of the customer´s operations. From the perspective of these customers of the TCOs, SRM is a critical process as it involves the suppliers (TCOs) in developing innovative solutions to solve the risks and improve the performance of their own operations (TCO´s customers), (Lambert & Schwieterman, 2012). Similar to the case company, there are other customers from the transportation industry to Telia and AT&T. These customers collaborate with Telia and AT&T on various projects such as energy savings, and route planning. Likewise, the case company can collaborate with its telecommunication service providers in similar projects. For instance, the case company can make use of the IoT systems provided by Telia and AT&T to track and monitor the energy consumption in their facility and reduce it through smart systems. The case company with their ambitions on autonomous mobility can make use of the latest network connection technology provided by the Telia and AT&T. Further, these novel technology solutions can enable smart decisions in route planning and reduce the

carbon emissions, which is highly beneficial for the case company with the vision of offering transport as a service. Also, Telia expressed their vision on working with the case company on sourcing mobile as a service, where the hardware powered by Telia´s network connection is sourced as a service. Lastly, according to Telia, e-sims is an area where they can collaborate with the case company in the mobile telephony services.

Demanding sustainability performance and metrics that are specific to telecommunications industry with a clear intent of improving and working towards sustainable development is important for the case company. This might require the case company to collaborate with the TCOs in understanding their risks and develop robust metrics. Also, the case company needs to investigate on new initiatives on making use of the supplier´s innovations to improve their overall performance. These are the ways on how the case company can adapt their relationship management and work towards sustainable development.

8 Conclusion and Recommendation

This chapter concludes the study and establishes the importance of the research to the case company. After the conclusion, strategic recommendations are provided to the case company to develop their strategies for responsible sourcing of telecommunications services

8.1 Conclusion

In efforts towards achieving the goals of the Paris agreement, it is important for Volvo Group to consider sustainability and move towards net zero greenhouse gas emissions within their operations and supply chain. Immense technological development within Volvo Group has led to lowering the GHG emissions and attaining sustainability within their own operations. In order to reduce the sustainability risks within the supply chain, efforts should be made to ensure that suppliers share the same vision and goals.

Further, Volvo Group expects their IT purchasing spend to increase in the coming years, especially with the network and telecommunications services. The reason for this is to support their vision of generating 50% revenue through providing transportation as a sustainable service, for which the IT systems act as the backbone. Thus, Volvo Group believes that it is necessary to investigate and develop robust responsible sourcing of telecommunications services as a start towards their sustainable IT purchasing journey.

The purpose of this research study was to investigate the sustainability risks within the telecommunications industry and their mitigation. And, based on these findings, analyze how Volvo Group can refine their sustainable procurement strategies. To achieve this aim, the authors investigated Volvo Group´s present way of sustainable telecommunication services procurement through conducting several internal interviews. Then, to understand the industry´s sustainability risks, a literature review was performed. In addition to the literature review, telecommunications services suppliers were interviewed. To achieve the aim of this research study, the following research questions were developed.

RQ1. *What are the potential supply chain sustainability risks for the case company in sourcing Network and Telecommunications (N&T) services?*

RQ2. *How can the supply chain sustainability risks that have been identified in RQ1 be handled to increase performance?*

RQ3. *Based on the findings from RQ1 and RQ2, how can Volvo Group assess the sustainability performance of the suppliers while procuring mobile and fixed telephony services?*

RQ4. *How could the findings from RQ3 be used in Volvo Group´s governance model to follow-up?*

RQ5. *How can Volvo Group adapt based on how other customers engage in sustainability initiatives with the mobile and fixed telephony service providers?*

The increase in the use of telecommunication services has made it important for the actors in the industry to develop strategies to reduce the associated sustainability risks and pave the way for sustainable development. To achieve this, the study identifies that the telecommunication operators

(TCOs) are setting up broad targets and climate action goals that are verified by SBTIs. Setting up sustainability strategies is noted to be one of the approaches that TCOs have taken up to reach their climate goals. The TCOs are also investing in carbon offsetting projects to compensate their carbon emissions to become carbon neutral, however they understand the necessity to achieve net-zero.

Energy consumption is one of the major risks associated with the telecommunications operations. The high energy consumption is associated to both the network equipment and network infrastructure (HVAC). The important initiatives that the TCOs are taking to mitigate this risk is to shift to 100% renewable energy usage and actively engaging in energy savings projects that make use of innovative technological solutions. The major energy savings initiatives taken by TCOs are noted in the table xxx in section 5.1.3. The study also identifies that the use of environmental management systems is highly effective to monitor and track the environmental impacts of the telecommunications operations. Fleet operations of the TCOs is observed to be contributing to significant emissions as well. Electrification of the vehicle fleet, and route management are a few of the approaches that TCOs are opting for reducing the fleet emissions.

The telecommunications operations involves a huge amount of resources such as the network hardware, which accounts for a lot of electrical and electronic waste, if proper care is not taken. In addition, there are wastes generated by the TCOs´ construction operations. Thus, it is important for the TCOs to handle these wastes by reducing the waste generation as a first step and then reuse, recycle and responsible manage the disposal as the last option. It is also identified in the study that it is essential to collaborate with the suppliers to jointly manage the waste.

This study shows the significance of considering sustainability risks within the multi-tier supply chain and not just limiting the analysis and efforts to direct supplier relationships, especially when sourcing services such as telecommunications services. The reason for this is that the network equipment manufacturers and construction contractors, who are suppliers to the TCOs, account for a significant part of the TCOs´ emissions. The production of network equipment leads to climate impacts like the embodied emissions during the production of base stations or the use of hazardous chemicals such as coolants in the air conditioners. Supplier code of conduct, assessment questionnaire, and onsite audits are the strategies adopted by the TCOs to mitigate the sustainability risks in their supply chain. Apart from assessing and evaluating the suppliers, TCOs communicate their sustainability goals, train their suppliers, and engage with them in achieving the goals. Although these telecommunication industry actors are present in Volvo Group´s extended supply chain, it is necessary for Volvo Group to ensure that the TCOs are handling the risks posed by the tier-2 suppliers in a responsible way.

Apart from the environmental sustainability risks, there are certain social sustainability risks inherent in the telecommunications industry. It was identified in the study that the complex supply chains of the TCOs are prone to social sustainability risks. TCO´s network equipment suppliers and their tier-2 suppliers having manufacturing in low labor cost countries are exposed to forced labor and child labor risks. Onsite audits by either themselves or in collaboration with audit partners are conducted at such

high-risk supplier locations to mitigate the risks. Further, the study notes that the use of conflict minerals in the network equipment makes it necessary for TCOs to have policies around mitigating these risks.
The internal interviews with people within the Volvo Group Purchasing helped the authors in understanding the various sustainable procurement strategies practiced. The review of Volvo Group´s current responsible sourcing practices shows that they are focused on automotive purchasing. Based on these findings, the authors evaluated the limitations of the current strategies to mitigate the specific sustainability risks identified in the N&T industry. Thus, the authors propose that Volvo Group needs to consider using a specific telecommunications sustainability questionnaire in order to bridge the gap between the present approaches in mitigating the identified sustainability risks. Also, it is not just enough to put forth a sustainability questionnaire in the RFP, there must be metrics developed to measure each of the sustainability risks which are to be used in the supplier governance model.
To conclude, this study investigated the best sourcing practices used by other customers of the TCOs. The mature customers of these TCOs collaborate with them in order to improve their responsible sourcing practices through developing pragmatic sustainability questionnaires that are systematically followed up. These findings imply that it is necessary for Volvo Group to consider such collaborative efforts as well.

8.2 Recommendations

In-order to ensure sustainable procurement of telecommunications services, Volvo Group must consider the specific sustainability risks identified in the study and mitigate these risks by demanding sustainability performance. To support such demands a relevant questionnaire is needed. For this purpose, we recommend Volvo Group to make use of the below sustainability questionnaire in the RFP as seen in Table 8.1. It is important to note that these questions need to be considered as a start of a process towards responsible sourcing of telecommunications services and the questions need to be developed on a regular basis to stay relevant. Since the questions address a broad range of sustainability risks, we recommend the IT buyers to use the questions as a basis to develop specific sustainability questionnaires adapted to their segments and product/service portfolios.

Table 8-1 RFP questionnaire

			Questions
Operations	**Climate**		
		1	What are your total carbon emissions for scope 1 and 2 and how much of your carbon emissions are reduced through offsetting?
		2	Do you have an environmental management system in place (For Ex: EAMS - verified or ISO - 14001 - certified)? What percentage of your facilities or operations make use of these management systems and

			are they certified? And do you provide training to your employees on these management systems?
		3	What share of your network sites have an energy measuring system and what is the Mobile/Fixed Network data Energy Efficiency (the data volume delivered / the energy consumption) and average energy consumption per subscriber?
		4	Mention the energy efficiency projects* to reduce the energy consumption of both the network infrastructure and the building HVAC? Provide metrics in relation to these projects (like energy savings from these projects)?
		5	Do you make use of dynamic power management systems (Using a smart system to dynamically optimize the energy consumption at a network site without affecting the service quality) at your network nodes and what share of these nodes have such solutions?
		6	Describe the energy reuse (usage of excess energy that would otherwise be dissipated into the environment unused) initiatives within your operations?
		7	What is your carbon usage effectiveness (CUE) associated with Co2 emissions from energy consumption, and average power usage effectiveness (PUE) at your sites?
		8	What are your measures or initiatives to reduce water consumption at your network sites and What is your average water usage effectiveness (WUE)?
		9	Are there any risks of water contamination due to the operations at base stations or other network infrastructure facilities and how are these handled?
		10	What is the share of renewable energy usage? Is it produced on site or procured with guarantees of origin and are these purchase agreements for the long term? What are your initiatives to scale up to 100% renewable energy usage in your operations?
		11	What types of renewable energy is used in your operations and what is the carbon footprint associated with it?
		12	What is your average Co-efficient of performance (COP) of your cooling systems used in your operations?

		13	Are there any measures taken towards reducing the fleet emissions to maintain and manage the network infrastructure?
		14	Could you elaborate on if there are any initiatives regarding the environmental impacts of 5g and of making it sustainable?
	People	1	Are all your sites monitored for compliance with EMF (electromagnetic fields) limits?
		2	How do you work with safety and labor health especially w.r.t to those who work with maintenance and operations (including the handling of hazardous chemicals from maintenance and other activities) of network infrastructure and how often do you provide training to them?
Supply chain	**Climate**	1	What share of your suppliers have environmental management systems such as EAMS or ISO - 14001 in place?
		2	Do you evaluate the maturity level of suppliers with respect to climate action goals and do you put demands on your suppliers to get their goals and targets aligned and approved by SBTi?
		3	How do you work with environmental sustainability in your supplier selection process and how much weight is given to these aspects in tenders?
		4	Do you evaluate or demand metrics from your suppliers regarding energy efficiency for the network equipment?
		5	Are there any specific environmental certifications such as Energy Star, TCO - certified or EU Ecolabel considered when procuring network equipment? If yes, what is the share of products or services procured with consideration given to these certifications?
		6	Do you have demands on suppliers regarding the restriction of certain hazardous substances and conflict minerals in the products procured from them?
		7	Apart from the code of conduct, do you make use of other industry specific assessment tools like Telecommunication Industry Association (TIA) assessor tool for the assessment of sustainability risks within the supply base?

		8	How do you ensure the use of sustainable construction materials in your construction activities for the network infrastructure that are performed by external contractors?
		9	What are your various innovation and collaboration projects with your network equipment providers for eco-design of network equipment?
	People	1	How do you ensure health and safety conditions of network construction and maintenance personnel who are working under suppliers and contractors?
		2	How do you mitigate the human rights risks such as forced labor, child labor, labor work conditions with respect to your network equipment manufacturing?
Circular Economy		1	Do you measure the waste generated from your operations (WEEE in kgs/tonnes per unit of turnover) and do you work with metrics such as the share of waste recovered for reuse and/or refurbishment or recycling from your own operations and from the operations of your suppliers? Further, what is the share of waste sent to landfills?
		2	How do you handle the wastes generated by your network construction activities?
		3	Do you have an asset management system governing the network equipment in your operations?
		4	Are there any strategies or initiatives with respect to sim cards (manufacturing, packaging and transport) to reduce their environmental impact and do you work with e-sims?
		5	How do you work with reusing the existing infrastructure to build new network lines?
		6	Certain network equipment contains hazardous substances, how do you handle such equipment?
		7	How do you collaborate with other network operators for infrastructure sharing? What percentage of your infrastructures are shared with other operators?

Further, it is recommended to the telecommunications sourcing team at the Volvo Group to collaborate on a continuous basis with the suppliers and develop robust metrics to assess the sustainability risks and to mitigate these risks, what could then be used in the supplier governance models. Also, similar to

other customers of the TCOs, Volvo Group can award price premiums or contract extensions to optimize all three dimensions of the triple-bottom-line (TBL). The TCOs other customers collaborate on innovative initiatives such as e-sims and mobile phones as a service. Volvo Group can collaborate on similar initiatives to make their telecommunications sourcing more sustainable.

The sustainability questionnaire recommended in the table xxx was forwarded to the three suppliers that were interviewed in this study to evaluate its practical relevance. The suppliers were requested to rate the questions on a scale of one to three (one being low and three being high) on their relevance and criticality to the telecommunications industry. In addition to rating, the suppliers were requested to provide comments on the questions if necessary. The responses from the suppliers are compiled in table xxx. We recommended Volvo Group to evaluate the responses from the suppliers and continue the discussions with them on improving the sustainability questionnaire.

8.3 Future Research

The findings and results for this thesis work are based on the interviews conducted with the suppliers located in Sweden and US which are the developed countries. The authors believe that the risks observed in the developed countries might not be the same as in the developing countries. So, the authors recommend future research in the developing countries, that is identifying the risks within operations and supply chain. Developing countries do not have labor laws similar to that of developed countries, the developing countries do not have environmental laws like developed countries. Due to these reasons authors believe the supplier questionnaire recommended will require more finetuning when considering the risks from the developing countries.

For the recommendations section, the authors suggest some sustainability questionnaires specific to the network and telecommunication industry. The suppliers interviewed in the process were asked to rate the questions based on relevance and criticality. The future research can be based in more detail on the specific segments which are assumed to be most critical by the suppliers. The research study will be more legit and relevant if the demands put by TCOs on their suppliers are inculcated within the study. This will also help to justify what are the most critical and relevant aspects that TCOs are expecting from their suppliers. Also, for future research and data collection, it is recommended by the authors that the interviews should be conducted with the personnel from the technical segments. In the current research the interviewees were associated with the sustainability department and lacked technical expertise and hence explanations within some projects were not presented in greater detail.

The authors believe that benchmarking the work done that is the process comparing with the competitors' key matrices and processes to learn and improve from other mature customers will help the evolution of their work. The authors can deeply study the models and approaches that other mature customer procuring N&T services will help their model of RFP questionnaire transform into a better and more matured model to demand more sustainable practices towards suppliers. This case study was focused on procuring mobile and fixed telephony services and the authors interacted only with the

buyers and contract managers (worked within IPS) associated with this area of working. To finetune and mature the model of RFP questionnaire for future research the authors can interact with the automotive purchasing segment within Volvo Group to mature their model on sustainability.

The authors worked to devise sustainability-based questionnaire to put forth their demands towards suppliers. Other departments within Volvo Group can use the approach and methodology used by authors to improve upon their work within sustainability. Although this is a case study specific to Volvo Group, other companies can give perspective by doing it in their study. Also, from an academic point of view, there are fewer case studies on the sustainable sourcing of services. Thus, this thesis could be considered as an addition to existing research and a relatively new field to explore.

Within recommendations authors suggested the usage of E-sims and mobile as a service. Collaborations with suppliers in this study will help in achieving more sustainable ways of working, For the N&T service within mobile telephony the key product from the supplier is a sim card by using E-sim will help to cut down on costs and reduce the plastic usage as e-sim will be an intangible service. Also, procuring mobile of service will serve the same purpose as Volvo Group will not require two separate contract that is one for mobile and another for the mobile telephony service. This will also help in cutting the administrative task related to two separate procurements. Table 8.2 summarizes the future research activities.

Table 8-2 Summary of Future Research

Future Research	Reason
Suppliers/TCO from developing countries	The risks observed might be different and also study was only guided by developed countries' TCOs
Based on reliability and criticality matrix as assessed by TCOs	Validity from the TCOs
Benchmarking	Learning and improving from other mature customers
Usage of devised model in other departments of Volvo Group	To learn and improve within their work within sustainability
E-sims and mobile service	More sustainable approach

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