UNIVERSITY OF OULU

FACULTY OF TECHNOLOGY

The use of digital tools in Scope 3 emissions reporting

Aliasghar Chehregosha Kenari

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ABSTRACT

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Aliasghar Chehregosha Kenari

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Supervisor(s) at the university: Jukka Majava, Mohammad Ayati

The CDP Global Supply Chain Report 2022 underscores the substantial impact of supply chain emissions, categorized as Scope 3 emissions, revealing their magnitude to be 11.4 times greater than operational emissions (Scope 1 and/or 2 emissions) on average. The act of measuring and reporting Scope 3 emissions signals a company's awareness of its environmental footprint and active engagement in efforts to reduce it.

This study focuses on exploring the significance and effects of utilizing digital tools for reporting Scope 3 emissions. Additionally, it aims to identify and address challenges associated with Scope 3 emission reporting and investigates EU regulations related to Scope 3 reporting. To accomplish our primary objective, we delve into the challenges that companies encounter when reporting on Scope 3 emissions.

This research was carried out as a qualitative study, utilizing a semi-structured interview to gather primary data from forest companies in Finland. Additionally, we utilized annual sustainability reports and company websites as secondary data sources. The research data were analyzed using the thematic analysis approach.

The main findings of the study underscore the importance of addressing challenges in Scope 3 emission reporting practices to promote sustainability. By identifying obstacles such as data consolidation, calculation model complexity, logistical data management, supplier collaboration, and integration of digital tools, the study sheds light on areas for improvement. Moreover, the study highlights the transformative role of digital tools, such as Business Intelligence (BI) platforms and integration with ERP systems, in streamlining reporting processes and enhancing accuracy and transparency.

Keywords: Scope 3 emissions, Digital tools, Sustainability reporting

FOREWORD

This thesis delves into the utilization of digital tools in Scope 3 emission reporting, a subject of increasing significance within the realm of sustainability management. Under the guidance of my supervisor, Jukka Majava, and co-supervisor, Mohammad Ayati, the research journey unfolded from September 2023 to April 2024. I am deeply grateful for their invaluable guidance and unwavering support, which has been pivotal in shaping the direction and outcomes of this study.

I would also like to express my heartfelt gratitude to my wife and son for their unwavering support and encouragement throughout this endeavor. Their patience, understanding, and encouragement have been a constant source of strength and motivation.

Espoo, 15.04.2024

Aliasghar Chehregosha Kenari

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LIST OF ABBREVIATIONS

AI: Artificial Intelligence

B2B: Business-to-Business

BI: Business Intelligence

BOM: Bill of Manufacture

CDP: Carbon Disclosure Project

CO2e: Carbon Dioxide Equivalent

CSRD: Corporate Sustainability Reporting Directive

EFRAG: European Financial Reporting Advisory Group

EGD: European Green Deal

ERP: Enterprise Resource Planning

ESG: Environmental, Social, and Governance

ESRS: European Sustainability Reporting Standard

EU: European Union

GHG: Greenhouse Gas

GRI: Global Reporting Initiative

IoT: Internet of Things

IT: Information Technology

LCA: Life Cycle Assessment

ML: Machine Learning

NFRD: Non-Financial Reporting Directive

SASB: Sustainability Accounting Standards Board

SCM: Supply Chain Management

SSCM: Sustainable Supply Chain Management

TBL: Triple Bottom Line

TfS: Together for Sustainability

UNFCCC: United Nations Framework Convention on Climate Change

WBCDS: World Business Council for Sustainable Development

WRI: World Resources Institute

1. INTRODUCTION

1.1 Background

Climate change is one of the very important challenges in the 21st century, exerting significant effects on both human societies and the overall environment worldwide. Addressing this critical issue requires a paradigm shift in the way businesses operate, necessitating a commitment to sustainable practices (Schulman et al., 2021). Corporations have started to assume responsibility by raising sustainability issues and making efforts to reduce emissions (Businesswire, 2020).

The categorization of greenhouse gas emissions into three scopes (Scope 1, Scope 2, and Scope3) provides a structured framework for understanding their sources and implications. Scope 1 encompasses direct emissions from a company's owned assets, while Scope 2 includes indirect emissions associated with external utility providers supplying electricity, steam, heat, and cooling. Scope 3, often termed value chain emissions, extends beyond a company's direct operations to include indirect emissions arising from external activities related to the production and use of the company's products or services (WBCSD & WRI 2004).

The CDP Global Supply Chain Report 2022 underscores the substantial impact of supply chain emissions, categorized as Scope 3 emissions, revealing their magnitude to be 11.4 times greater than operational emissions (Scope 1 and/or 2 emissions) on average (CDP, 2022). The act of measuring and reporting Scope 3 emissions signals a company's awareness of its environmental footprint and active engagement in efforts to reduce it, thereby underscoring a commitment to environmental responsibility, as highlighted by the Environmental, Social, and Governance Reporting Standards (ESRS, 2023). Also, The European Sustainability Reporting Standards (ESRS), mandated by the new Corporate Sustainability Reporting Directive (CSRD) from the EU as part of the Green Deal, will require many companies to disclose Scope 3 emissions for the first time (EFRAG, 2022b).

In the contemporary era, digital technologies have emerged as instrumental tools facilitating the seamless transmission of information across internal departments and external stakeholders within the supply chain (Himanshu, 2020). This thesis delves into determining the current state of Scope 3 reporting and the current challenges in Scope 3 reporting. It explores how digital tools can help mitigate these challenges and fill the gap between the desired state of reporting and the current state.

1.2 Research objectives and questions

This thesis concentrates on the significance and effects of employing digital tools for reporting Scope 3 emissions within the sustainable supply chain. To achieve its primary objective, the study investigates EU regulations related to Scope 3 reporting and delves into the challenges that companies encounter when reporting on Scope 3 emissions. Additionally, it assesses their current reporting status and their utilization of digital tools in this matter.

In accordance with background and goals, following research questions (RQs) have been established:

RQ1: What are the upcoming reporting requirements for companies regarding Scope 3 emissions in the supply chain?

To know the future rules and guidelines or other requirements in Scope 3 emission reporting that companies will need to comply, this question should be answered.

RQ2: What are the challenges of Scope 3 emission reporting for companies?

To gain insights into the current challenges that the companies face to report Scope 3 emission and to recognize the current status of reporting, respond to this question can be useful.

RQ3: What digital solutions are available and how can they help bridge the gaps in achieving desired level of Scope 3 emissions reporting?

To identify available digital solutions and to understand the significance and influence of them in the reporting process and solving its challenges, along with their impact on the report's reliability, the answer to this question can be informative.

1.3 Research structure

This thesis comprises five chapters. It begins with an introductory chapter that sets the stage by outlining the background and research issue, stating the aim and research questions, illustrating the conceptual framework, and defining the key concepts under investigation. The theoretical underpinnings of the study are covered in the second chapter, which discusses the introduction to Sustainable Supply Chain Management, Scope 3 emission reporting, upcoming directives regarding reporting, and the impact of digital tools in Scope 3 reporting. The third chapter introduces the study's research methodology, including data gathering and analysis techniques, as well as empirical findings. The empirical findings are then consolidated and analyzed in the discussion chapter in consideration of the research questions. Subsequently, the conclusion chapter encapsulates the primary findings of the study and offers recommendations for future research endeavors.

2 LITERATURE REVIEW

2.1 Sustainable supply chain management (SSCM)

The focus of supply chain management (SCM), in the traditional version, is on the triple management of information, capital flow, and materials (Seuring & Müller, 2008). According to increasing socio-environmental problems such as climate change, air quality, and pollution-related diseases, the concept of sustainability has been considered over the last decade (Khan et al., 2020). The most common definitions of SSCM which is provided by Seuring & Müller (2008, p. 1700): "Managing the movements of resources, information and finances, along with the collaborative efforts among companies within the supply chain, while considering objectives related to sustainable development in terms of economic, environmental, and social aspects. These objectives are based on the needs and expectations of both customers and stakeholders."

In addition, in another definition that Dyllick and Hockerts (2002) provide the sustainable version of SSCM, it is referred to as an incorporation of sustainable development in which economic issues, social issues and environmental issues are considered, for supply chain management and human development. The main emphasis of SSCM is on achieving equilibrium among environmental conservation, economic expansion, and societal progress (Elkington, 1997).

In this regard, the concept of the "House of Sustainable Supply Chain" is introduced by Teuteberg an Wittstruck (2010), based on the three elements of the Triple Bottom Line (TBL) that suggests beyond a company's financial success, it is crucial to factor in its influence on both the environment and society. These three aspects are commonly denoted as people, planet, and profit, as indicated by Meijer and Schuyt (2005). These elements are considered the vital required supports to maintain equilibrium within the structure, while risk and compliance management serve as the foundation of the house. Implementing SSCM also necessitates instilling values and ethical principles across the entire organization, creating an effective and adaptable environmentally friendly IT infrastructure, and aligning the corporate strategy with a sustainable development focus. By implementing these measures, the network can be safeguarded effectively from environmental and societal dangers and uncertainties. Although SSCM offers more comprehensive benefits in terms of the TBL compared to traditional SCM, it is also more time-consuming and demanding. This approach requires considerable efforts to foster alignment and collaboration among chain members (Seuring & Müller, 2008a; Sharfman et al., 2009).

SSCM, supported by corporate leadership, plays a pivotal role in helping companies and stakeholders collaboratively address Scope 3 emission reporting. According to Patchell (2018), SSCM offers an efficient approach to tackle Scope 3 emission reporting. Within the SSCM framework, stakeholders' mutual interdependence becomes vital in abating Scope 3 GHG emissions, emphasizing the importance of collaboration (Lee, 2005).

In the corporate context, the most substantial opportunity for mitigating climate change through the implementation of SSCM is found in the reduction of Scope 3 emissions (Downie & Stubbs, 2012; Matthews et al., 2008), so, SSCM offers an efficient approach to tackle Scope 3 emission (Patchell, 2018). Developing a successful SSCM strategy for Scope 3 emission reporting requires shared values regarding environmental and social sustainability, economic efficiency, responsibility, control, coordination methods, and sustainability goals. So, the principles of SSCM have influenced the creation of the Corporate Value Chain (Scope 3) Accounting and Reporting Standard (WRI/WBCDS, 2011).

The practices of SSCM are highly relevant to addressing the challenges of Scope 3 emissions reporting such as supplier engagement and resource limitations (Lee & Klassen, 2008; Patchell, 2018). These challenges can be effectively addressed by cultivating environmental capabilities within the supply chain through SSCM practices like supplier co-creation and collaboration (Lee & Klassen, 2008). Furthermore, companies can contribute to sustainability by sharing environmentally friendly practices and technologies with their suppliers, thereby reducing greenhouse gas emissions throughout the corporate supply chain (Lee, 2011). SSCM is an efficient solution for handling Scope 3 emission reporting (Patchell ,2018). Parties within SSCM are mutually reliant, which plays an important role in Scope 3 GHG emission abatement. Successful decarbonization across the supply chain requires collaboration among stakeholders (Lee, 2005).

2.2 Greenhouse gas emissions (GHG)

Climate change presents one of the most pressing challenges of the 21st century, affecting both people and our planet. This necessitates a fundamental shift in how businesses operate, embracing a more sustainable approach (Schulman et al., 2021).

Management of greenhouse gas (GHG) emissions is now considered essential for companies. Recognizing a company's GHG impact requires a robust corporate climate change strategy. To guide sustainable practices and foster real change, various approaches and guidelines have been put in place by WRI/WBCDS (2011). The GHG Protocol Corporate Standard, a commonly employed framework, categorizes emissions into three scopes: Scope 1, encompassing direct emissions; Scope 2, which accounts for indirect emissions from purchased energy utilized in company-owned or controlled equipment or operations; and Scope 3, which incorporates additional indirect emissions across the firm's value chain (Schulman et al., 2021).

2.2.1 Scope 1,2 and 3

The concept of "scope" was introduced in the Greenhouse Gas Protocol, which was created by WBCSD and WRI. The Greenhouse Gas Protocol, sometimes known as the GHG Protocol, establishes consistent frameworks for assessing and controlling greenhouse gas emissions. This concept arose from the universal need for a single standard for monitoring and reporting company greenhouse gas emissions (WBCSD & WRI 2004).

To distinguish between emissions that are directly produced by an organization and those that are indirectly associated with it, greenhouse gas emissions are categorized into three distinct scopes (Scope 1, Scope 2, and Scope 3). Scope 1 emissions encompass direct emissions originating from a company's owned assets within its value chain. For instance, airlines generate Scope 1 emissions by burning jet fuel during the operation of their owned aircraft. Scope 2 emissions are considered indirect emissions arising from the consumption of electricity, steam, heat, and cooling within a company's operations, often supplied by external utility providers. An example of Scope 2 emissions can be seen in grocery stores using appliances, lighting, and refrigeration equipment. Scope 3 emissions, frequently referred to as value chain emissions, constitute indirect emissions resulting from all other activities involving assets not owned by the reporting company but associated with the production and usage of the company's products or services (WBCSD & WRI 2004).

Scope 3 emissions are divided into 2 activities categories (Upstream and Downstream) and 15 sub-categories. Upstream emissions are emissions generated prior to the moment a reporting company takes ownership of purchased goods and services. They are associated with the production and transportation of raw materials or products in the supply chain. Downstream emissions occur after the reporting company has received products and services and are associated with their use by consumers or other businesses further down the supply chain. (WBCSD & WRI 2011)

Table 1. Scope 3 categories (adapted from WBCSD & WRI, 2011)

Upstream	Downstream
1. Purchased goods and services	1.Downstream transportation and distribution
2. Capital goods	2. Processing of sold products
3. Fuel- and energy-related activities (not included in scope 1 or scope 2)	3. Use of sold products
4. Upstream transportation and distribution	4. End-of-life treatment of sold products
5. Waste generated in operations	5. Downstream leased assets
6. Business travel	6. Franchises
7. Employee commuting	7. Investments
8. Upstream leased assets	

2.2.2 Scope 3 emission reporting

In the face of the daunting challenge of climate change, it is incumbent upon governments, corporations, and consumers to collectively shoulder the responsibility of reducing greenhouse gas (GHG) emissions (Rekker et al., 2021). A pivotal instrument in this endeavor is the reporting of Scope 3 emissions, as meticulously explored in the comprehensive study by Scott, Roelich, Owen, and Barrett (2018). This reporting acts as a beacon of transparency, illuminating the emissions intricately woven into production processes. Its power lies in the revelation of emissions, guiding firms towards strategic intervention points (Scott et al., 2018). As a result, assessing a company's sustainability performance is widely recognized to require measurable indicators (Özdemir et al., 2011).

The Greenhouse Gas Protocol offers a reporting method designed to help businesses in reporting their climate effect in an organized and precise manner by dividing emissions into three Scopes. There are several ways for determining Scope 3 emissions, each with differing degrees of precision and specificity. The Greenhouse Gas Protocol states that the most precise approach to estimate upstream Scope 3 emissions is to get data directly from the source of the good or service. If the reporting organization does not have access to supplier-specific data, these emissions can be estimated using either a spend-based technique or an average-data method. (GHG Protocol, 2011).

The spend-based technique necessitates that the reporting firm gathers expenditure associated with the acquired goods and multiplies it by emission factors for an industry average. The average-data technique multiplies relevant units, such as product mass, by an industry average emission factor. The spend-based and average data methods are less detailed than the Supplier-specific technique, but they are also not necessarily less accurate. The Supplier specific technique is dependent on the supplier gathering and allocating the proper emissions data, which may be less accurate than the average method. A hybrid strategy combining existing data from suppliers and filling in any gaps with average data is an alternative (GHG Protocol, 2011). An efficient strategy for reporting Scope 3 emissions demands the personal dedication of top management to mitigate the company's environmental footprint. Additionally, it requires active involvement from supply chain stakeholders in the organization's sustainability initiatives, along with strategic planning to enhance overall supply chain sustainability (Orr & Jadhav, 2018).

2.2.3 Importance of Scope 3 emission reporting

According to the Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report, GHG emissions from human activities are the primary cause of today's climate change. Global warming of 2°C will be exceeded in the twenty-first century unless GHG emissions are significantly reduced in the following decades. Limiting human-induced global warming to a given level requires achieving net zero CO2 emissions. Cumulative CO2 emissions must be restricted, and other GHG emissions must be significantly reduced as well (IPCC, 2021).

To keep on the predicted path of limiting global warming to 1.5°C (IPCC, 2022), global GHG emissions would have to peak by 2025. This global climate effort relies heavily on supply chain decarbonization. Companies must begin to manage emissions throughout their whole supply chain; however, it is a hard task (2021 World Economic Forum). According to EFRAG (2022a), Scope 3 emissions are a significant factor in the transition risks that businesses must deal with. As per the CDP Global Supply Chain Report 2022, the supply chain emissions, which are categorized as Scope 3 emissions, are 11.4 times more than operational emissions (Scope 1 and/or 2 emissions) in average (CDP, 2023).

Scope 3 emissions may comprise as much as 90% of all emissions. Because of their size, tackling Scope 3 emissions is vital in order for companies to demonstrate a genuine commitment to combatting climate change (World Economic Forum, 2021).

The requirement for corporations to disclose their Scope 3 emissions not only enhances their understanding of their societal and environmental impact but also promotes a more profound comprehension of mitigation strategies. This development presents a favorable opportunity for businesses to embrace responsibility for the sustainability of their supply chains. By measuring and reporting Scope 3 emissions, companies signal to stakeholders, including investors, customers, and employees, that they are cognizant of their environmental footprint and actively engaged in efforts to reduce it, underscoring their commitment to environmental responsibility (EFRAG, 2023). So, the most substantial potential for mitigating climate change within companies is found in the reduction of Scope 3 emissions, as indicated by the works of Downie & Stubbs (2012) and Matthews et al. (2008).

2.2.4 Challenges related to Scope 3 emission reporting

In order to examine the challenges related to Scope 3 emission reporting, the CDP (2023) identifies limited data transparency and low data quality as barriers (CDP, 2023). Scope 3 reporting precision is strongly reliant on the quality of emission data and, when such data is unavailable, the dependability of emission factors used to translate activity or volume values into CO2 emission equivalents. As Downie and Stubbs pointed out in their study, this component of reporting is extremely challenging. (Downie & Stubbs, 2012)

Scope 3 reporting's intricacy is heightened by the challenge of multiple counting emissions. This term highlights the issue where indirect emissions are frequently counted more than once, sometimes even two or three times, due to substantial overlap in a firm's value chain (Patchell, 2018) or in other word, Due to the distinctions between scope 1, 2, and 3 emissions, what constitutes one organization's scope 3 emissions may be perceived as another organization's scope 1 or 2 emissions (Hertwich & Wood, 2018).

The issue of comparability between companies is also prominent in scope 3 reporting. Variations in methodologies and emission factors utilized by different organizations hinder the ability to compare and track progress effectively (Borglund, Grafström, and De Geer, 2021). These differences are further magnified by the diverse range of Scope 3 emissions included by organizations (Downie & Stubbs, 2013).

Scope 3 emissions reporting is frequently referred to be a difficult and expensive task (McKinnon, 2004), Because on the supplier side, there are various challenges, including a lack of time, interest, and knowledge in environmental management, that restrict their capacity to satisfy their customers' environmental needs in a timely and determined manner (Lee & Klassen, 2008). In other words, reporting Scope 3 emissions may be both expensive and time-consuming. Gathering and evaluating data from diverse sources along the value chain, engaging stakeholders, and executing sustainability measures may all require substantial time, money, and resources (World Economic Forum 2021). This is a significant barrier for companies, particularly small and medium-sized businesses, which may lack the resources required for full sustainability reporting (Jouven & Schmidt, 2022).

2.3 Corporate sustainability reporting directive

EU was the first to develop the so-called EU taxonomy, which delineates sustainable activities and disclosure guidelines for financial market participants and large enterprises (Sipiczki, 2022).The European Union, as part of the European Green Deal strategy, has decided to introduce regulations that will make the vast majority of companies report their environmental and human impact activities. the Non-Financial Reporting Directive (NFRD), which came force in 2014, already obliges large public entities to report on ESG (European Parliament and European Council, 2014). The NFRD, implemented across all EU member states in 2018, marked a significant move towards mandatory disclosure of sustainability-related information (FEE, 2016; Krasodomska et al., 2022; Reverte, 2020). However, it faced challenges due to insufficiently detailed requirements, a multitude of overlapping and sometimes inconsistent reporting frameworks and standards, and a lack of enforcement and credibility in the disclosures provided (EU, 2020). Addressing these issues, the European Union introduced the Corporate Sustainability Reporting Directive (CSRD) on 5 January 2023 (EU, 2023).

The CSRD mandates public-interest entities, including large, small, and medium-sized undertakings (excluding micro-businesses), to include specific information in their sustainability reports. This information encompasses details about the business model, resilience and strategy towards sustainability risks, plans for transitioning to a sustainable economy, actions contributing to limiting global warming, and reduction of greenhouse gas emissions. Furthermore, companies must describe steps taken to ensure due diligence in accordance with EU requirements, along with the impact of these measures on their operations, value chain, and supply chain. The reporting should also cover principal risks, risk management strategies, and appropriate measurable and verifiable metrics (Borowicz & Czerepko, 2023).

The companies falling within the scope of the CSRD will soon be obligated to furnish more comprehensive sustainability information. This requirement aligns with the impending European Sustainability Reporting Standard (ESRS) to be incorporated into their management reports (Krasodomska et al., 2023).

2.3.1 The Paris agreement

The Paris Agreement is an international convention named after the city of Paris, France, where it was signed in December 2015. Its principal goal was to minimize the emissions of greenhouse gases that cause global warming. The Paris Agreement attempted to improve on and succeed the Kyoto Protocol, a previous international deal designed to control greenhouse gas emissions. It went into force on November 4, 2016, and had garnered signatures from 195 countries and ratifications from 190 countries as of January 20, 2021 (UNFCCC, 2015).

The main objective of the accord was to actively work to keep the rise in global temperature to 1.5°C and to keep it well below 2°C above preindustrial levels. It was suggested that all parties involved should aim to reach the peak of greenhouse gas emissions on a global basis as soon as possible and then execute quick reductions to accomplish this. The ultimate goal was to establish a balance, possibly incorporating technologies for carbon dioxide capture and storage from power plants, between greenhouse gas emissions from sources like power plants and fossil fuel-burning engines and their removal through natural sinks (like forests and oceans), beyond 2050 (UN, 2023).

2.3.2 European green deal (EGD)

The European Green Deal represents the European Union's fresh growth strategy, seeking to reshape the EU into an equitable and prosperous society with a competitive economy. It serves as a cornerstone of the European Union's strategy to attain the Sustainable Development Goals by 2030 (European Commission, 2019).

The European Union should be net carbon neutral by 2050, and economic development and resource usage should be uncoupled from one another. The EGD, which outlines the aspirations and goals in many policy areas, is not a law in and of itself. Rather, it is a broad policy approach. Over the following several years, current legislation and directives will be written and put into effect, along with new rules and standards (European Commission, 2019).

The Commission's Work Program for 2021 is guided by the 2030 Agenda and the Paris Agreement, setting the stage for achieving a 55% reduction in greenhouse gas emissions compared to 1990 levels through the "Fit for 55" package. Emphasis will be placed on utilizing renewable energy sources, enhancing energy efficiency, fostering a more circular economy, promoting biodiversity, ensuring a toxic-free environment, and advancing sustainable and intelligent mobility (European Council and Council of the European Union, 2023).

2.3.3 EU Taxonomy

The EU's taxonomy offers businesses and investors a standardized approach for evaluating the environmental sustainability of a particular economic activity in an effort to strengthen the link between finance and sustainability. According to the EU's revised taxonomy, a project must benefit at least one of the six environmental aims (climate change mitigation, climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, pollution prevention and control, and protection and restoration of biodiversity and ecosystems) while causing no harm to the other objectives. Simultaneously, the activity must conform to the International Labor Organization's (ILO) basic social and governance protections, such as fundamental human rights and minimum salaries (TEG, 2019).

The taxonomy applies to players in the financial markets, significant corporations, the EU, and individual Member States. In advance of contracts and in regular reports, financial market players providing financial products in the EU must provide information about their efforts to tackle climate change. According to the 2020 Technical Expert Group (TEG) rules, they will also be required to report on the amount of their engagement in environmentally friendly economic operations, so the taxonomy addresses climate change and sustainability reporting obligations for various EU businesses (TEG, 2020). Technical Expert Group (TEG) on sustainable finance, was established by the European Commission. It is comprised of 35 members representing various sectors, including civil society, academia, business, and the finance sector. Additionally, there are 10 additional members and observers hailing from the European Union (EU) and international public bodies (European Commission, 2018).

2.3.4 EU NFRD and CSRD

The Non-Financial Reporting Directive (NFRD), which was introduced by the European Union in 2014, helped it become a pioneer in the field of sustainability reporting. This occurred before the UN Sustainable Development Goals in 2015 and the Paris Agreement (EFRAG, 2021).

The NFRD mandates that large public-interest entities with over 500 employees disclose information on environmental, social, and employee-related matters, human rights, anti-corruption measures, and board diversity. This requirement applies to approximately 11,700 companies operating within the EU (European Commission, 2022).It was a crucial first step, but the EU believed more regulations should be required for sustainable reporting. (EFRAG, 2021)

The Corporate Sustainability Reporting Directive (CSRD), which replaced the NFRD, was published by the EU Commission in April 2021 and came into effect on January 5, 2023. It introduced a new framework that enhances rules governing the sharing of social and environmental data by businesses. All major enterprises and listed corporations are now obligated to produce sustainability reports, which must be validated by a third party with limited assurance and adhere to a yet-to-be-determined unified EU standard. By mandating businesses to report on their sustainable practices, this directive expands the scope to include a broader range of major corporations and even listed small and medium-sized enterprises (SMEs). These revised standards aim to ensure that stakeholders and investors have easy access to the data necessary to assess a company's social and environmental impacts. They also enable investors to evaluate the financial risks and opportunities associated with issues such as climate change and other sustainability concerns. The ultimate goal of the CSRD is to standardize reporting processes and expedite them, saving long-term expenses for businesses (European Commission, 2023).

The new laws will be implemented for the first time in the fiscal year 2024, with reports issued in 2025 being the first to follow these requirements. Companies subject to the CSRD are required to comply with the European Sustainability Reporting Standards (ESRS). The European Financial Reporting Advisory Group (EFRAG) brings together a wide variety of stakeholders to develop these standards. These standards will be customized to match EU objectives while also contributing to global standardization efforts. Furthermore, the CSRD establishes rules for assurance on the sustainability information given by corporations and will assist the development of a digital taxonomy for sustainability information. (European Commission, 2023)

2.3.5 European Sustainability Reporting Standards (ESRS)

The European Sustainability Reporting Standards (ESRS), created by the independent European Financial Reporting Advisory Group (EFRAG), will govern reporting under the new CSRD framework. These standards are intended to comply with EU policies and laws such as the Non-Financial Reporting Directive (NFRD), EU Taxonomy, and the Corporate Sustainability Due Diligence Directive (CSDDD) (European Commission 2023c, 2023d).

A comprehensive set of Environment, Social, and Governance Standards has been created by the European Financial Reporting Advisory Group (EFRAG), and it consists of five environmental standards (ESRS E1-E5) that address climate change, pollution, water and marine resources, biodiversity, and resource management. While one governance standard (ESRS G1) places an emphasis on ethical corporate behavior, the other four social standards (ESRS S1–S4) cover the workforce, value chain employees, communities, and consumers (EFRAG 2023).

The disclosure requirements for Scope 3 emissions are outlined in the ESRS E1 Climate Change draught standard. Companies are required to provide particular details in their reports, such as Gross Scope 3 GHG emissions, Total GHG emissions, Percentage of emissions calculated using primary data, - 1.5°C aligned reference target values for Scope 3 emissions if relevant, Reporting boundaries, calculation methods, and calculation tools (EFRAG, 2022a).

Companies are required to disclose Gross Scope 3 GHG emissions in metric tons of CO2 equivalent, with an emphasis on important Scope 3 categories. This comprises selecting and reporting emissions from the most important categories to the firm. As indicated in EFRAG 2022a, enterprises must analyze their total Scope 3 emissions and identify the most relevant categories based on variables such as emission levels, financial expenditures, and related transition risks (EFRAG 2022a). The reporting must take into account the principles and standards outlined in the GHG Protocol Corporate Standard (EFRAG 2022b).

The emissions of Scope 3 greenhouse gases from a company's parent, subsidiaries, associates, and operationally controlled unconsolidated subsidiaries must be reported. The reporting company's Scope 3 should include emissions from partners, joint ventures, and unconsolidated subsidiaries without operational control if they form a link in the value chain. (EFRAG 2022a)

In addition, the E1 standard requires enterprises to routinely update their fundamental Scope3 inventory every three years. Any Scope 3 category that is excluded from the inventory must have a justification. (EFRAG 2022a) Companies subject to the CSRD and ESRS laws will be required to phase in the updated reporting requirements over the next five years.

- Large firms with more than 500 workers must first comply for the fiscal year 2024, with their first reporting due in 2025.
- The second phase, scheduled for 2025, will include major enterprises that fulfil two of the following criteria: having more than 250 workers, having a net turnover in excess of 40 million euros, or having a balance sheet total in excess of 20 million euros.
- Listed SMEs, small credit institutions, and captive insurance firms will be required to comply with the reporting standards in 2026, with their starting reporting duties beginning in 2027. They do, however, have the option to postpone compliance until 2028 if they so want.
- Non-EU enterprises with at least one subsidiary and a net turnover of more than 150 million euros within the EU will be obliged to undertake Scope 3 reporting beginning in early 2028, as stipulated in the CSRD and ESRS laws. (European Union 2022; EFRAG 2023)

2.4 Digital tools utilization in Scope 3 emission reporting

Digital technologies aim to facilitate the transmission of seamless information both internally, between various departments like marketing, sales, purchasing, finance, production, distribution, and transport, and externally between consumers, vendors, and carriers throughout the supply chain (Himanshu, 2020). Digital tools assume a pivotal role in guaranteeing the transparency, availability, and dependability of emissions data. Through the utilization of these tools, corporate leaders acquire essential insights that enable them to make informed judgments regarding strategies for emission reduction.

These insights also aid in pinpointing the precise areas and the degree to which emissions can be curtailed (Buchholz, 2023). Also, e-collaboration, serving as robust IT support, enables the coordination of diverse decisions and activities that extend beyond mere transactions among partners in the supply chain. This is applicable to both suppliers and customers and takes place not only over the Internet but also across other interorganizational information systems (Cassivi et al., 2008).

2.4.1 Enterprise Resource Planning (ERP)

Enterprise Resource Planning (ERP) is a customized system designed to manage, integrate, and support processes across an organization's boundaries. It streamlines operations and enhances service value (Doom et al., 2010; Savoy & Salvendy, 2016). ERP systems help firms in establishing the foundation for various functions, including supply chain management, customer relationship management, knowledge management, strategic management, and decision support systems (Shiau et al., 2009).

As per Krajewski et al. (2016), ERP systems serve as consolidators of information from multiple systems and processes throughout an organization. They create a centralized hub for viewing all components of the organization, eliminating the need to extract data from disparate systems. This consolidation of information empowers managers and leaders by providing access to comprehensive data for making more informed and well-suited decisions (Grezek, 2020). Moreover, ERP systems offer supply chain management access to global transactional data, enabling more intelligent decision-making within the supply chain context (Chopra & Meindl, 2016). The integration of suitable ERP systems within the supply chain leads to enhanced data accuracy and more streamlined decision-making processes, primarily through transparent reporting (Mangaladurai & Nemati, 2013).

Implementing a comprehensive carbon accounting and reporting system within an ERP framework involves several key steps. First, entries for carbon inventory items should be established in the ERP system's inventory item master. This includes creating a detailed Bill of Manufacture (BOM) for each product, specifying the consumption of carbon inventory items per finished good unit. To assess the energy impact, a straightforward method can be employed by calculating the average carbon footprint per operating hour, derived from the overall energy cost (measured in CO_2e) divided by the total number of work center operating hours. Additionally, the carbon footprint from shipping can be evaluated, with the option to either approximate values or obtain precise data from carriers. Finally, to streamline the process, automation can be implemented for carbon calculations and reporting. This involves integrating the aforementioned methods into the ERP software, allowing for the autonomous computation of carbon costs associated with each item. The system can then generate insightful reports on carbon costs, categorized by item, customer, or category, akin to standard inventory reporting (Bieszczat, 2023).

2.4.2 B2B collaboration

E-collaboration, as defined by Johnson and Whang (2002), encompasses business-to-business collaboration that is made possible by the Internet. These interactions extend beyond basic buy/sell transactions and are better characterized as relationships. They involve various activities such as sharing and integrating information, making decisions collectively, collaborating on processes, and sharing resources (Johnson and Whang, 2002). Also, Cassivi et al. (2008) noted that in the context of a supply chain, e-collaboration goes beyond simple transactions and assists in coordinating diverse interactions and operations across the supply chain network, whether they are suppliers or customers. This collaboration takes place over the internet and through other interorganizational information systems. In this regard, a Business-to-Business (B2B) e-marketplace offers robust IT support to enterprises that are implementing Supply Chain Management (SCM). This B2B platform acts as the foundation for all firms participating in the supply chain to share information and improve their connections. Companies may use a B2B e-marketplace to increase the operational efficiency of their supply chain, promote e-business broadly, and transform the supply chain management strategy (Cassivi et al., 2008). As highlighted by Lee (2007), the sharing of information within business units (internal customers/partners) as well as with suppliers and other strategic partners (external customers) is indispensable to ensure the seamless execution of a supply chain plan, maximize the benefits of execution, and gain a competitive edge. This underscores the importance of further insights into the decisions related to adopting e-collaboration, as argued by Chan et al. (2012).

The company's Scope 3 emissions are consolidated for the entire organization, but accurately determining these emissions from the supply chain necessitates activity data regarding inputs from suppliers. It is crucial for the emission factors associated with these inputs to be as precise as possible, emphasizing their relevance to specific products. If suppliers have formulated footprints specific to their organization, a straightforward method involves scaling down their overall emissions to products, based on factors such as quantity or value, and subsequently deriving corresponding emission factors. A proposed solution, advocated by numerous Life Cycle Assessment (LCA) experts, involves accounting for all a company's products with individualized product footprints tailored to their respective causes. In the B2B collaboration, the emission factors associated with individual products can then be conveyed to the customer (Schmidt, Nill, & Scholz, 2022).

2.4.3 E-procurement

E-procurement encompasses the use of electronic methods across all stages of the purchasing process, From identifying needs to completing payments, and potentially overseeing contracts (Slack et al., 2013). The objective of e-procurement solutions is to automate workflows and optimize the procurement process to improve supply chain efficiency (Davila et al., 2003).

In simpler terms, e-procurement involves the online purchase of goods and services. E-procurement solutions encompass three key procurement areas: procurement transactions, procurement management, and market-making. They also impact four major operational procurement activities, including product or service searches, order processing, monitoring and control, and coordination of relevant information. Buyer organizations commonly integrate e-procurement solutions with their existing information systems, including ERP systems. This integration allows these companies to harness essential enterprise data present in their ERP systems. On the supplier's side, the e-procurement solution is frequently connected to the supplier's order fulfillment system or the product catalogs accessible on the supplier's website (Subramaniam & Shaw, 2004).

In the reporting process, in addition to automating, e-procurement enhances primary data availability and quality by collecting more data from suppliers and ensuring its verification. Additionally, it incorporates high-quality secondary data, using industry averages for emission factors per location for a broader perspective. The strategy involves pinpointing emission hotspots in the supply chain through spend analysis, determining influential suppliers or categories (Pirttijärvi, 2022).

2.4.4 Digital twin

Digital twin is a dynamic virtual replica of a real-world system that utilizes data from various sources for anomaly detection and long-term forecasting. This concept bridges the physical and virtual realms, enhancing visibility and informed decision-making across supply chain operations. It empowers businesses to adapt to changing conditions and achieve improved outcomes (Grieves & Vickers, 2017). Additionally, a Digital twin is a digital copy of an object or process that tracks behavior changes through sensor data, allowing real-time performance monitoring and forecasting (Qi et al., 2021).

A supply chain digital twin is a virtual depiction of the actual supply chain. Because of this, a digital twin may simulate the operation of a physical supply chain and quickly identify when changes or revisions are required in response to shifting circumstances (Christopher, 2023).

2.4.5 Blockchain

Swan (2015) defines blockchain as a distributed database system that captures transaction data and other information and is maintained by a consensus process. Asymmetric encryption techniques, distributed data storage, consensus algorithms, and smart contracts are the four basic technologies of blockchain technology. Because of various coding approaches, asymmetric encryption algorithms are more secure (Diffie and Hellman, 1976). By producing an irrefutable record on the public ledger, blockchain provides a distributed consensus method that assures participant entities are aware of every transaction. Encryption methods and dispersed data storage secure the data in the system (Wu & Tran, 2018).

In addition to the well-known benefits of blockchain technology, such as faster transactions, improved information exchange, and transparency, its major purpose is to improve transaction security. Some of the key reasons why blockchain technology is gaining traction in supply chain management include its robust and dependable structure (Hawlitschek et al., 2018), its capacity for traceability, its enhancement of supplier evaluation processes (Kouhizadeh and Sarkis, 2018), its ability to optimize purchasing functions (Rane and Thakker, 2019), and its potential to reduce cohesion.

Blockchain technology allows organizations to acquire and report larger datasets, including massive quantities of new metadata. This comprises information such as when the data was gathered, the data sources (e.g., internal databases, external providers), geographical locations, and more. In this regard, it is a suitable tool for monitoring and reporting emissions of scope 3 through the development of an immutable and transparent data chain with the potential to provide accessible and standardized information to all relevant parties (stockle, 2023).

2.4.6 Artificial Intelligence (AI) and machine learning (ML)

AI is characterized by computers' capability to independently address problems, even when they haven't been explicitly programmed for a specific task. Contemporary AI platforms can collect data from their environment and are designed to employ logic and probability when making decisions and taking actions with the highest likelihood of success. AI leverages large datasets, as well as visual and auditory inputs, to operate intelligently and demonstrate remarkable precision in recognition and decision-making (Dash et al., 2019).

In an alternative definition, AI encompasses a series of processes which involve learning (acquiring information and rules for its utilization), reasoning (employing rules to reach approximate or definite conclusions), and self-correction, enabling machines to learn from experience. This is facilitated by providing machines with a wealth of data, allowing them to execute tasks akin to those performed by humans (UN, 2020).

AI processes and analyzes vast amounts of data to offer personalized recommendations driven by emerging trends. In supply chain management, AI's role is pivotal in automating processes, as even minor alterations in the supply chain configuration can lead to unexpected outcomes. AI, a branch of software engineering, focuses on developing systems that can mimic human-like functions. It relies on machine-formed human intelligence and is increasingly integrated into supply chain and logistics operations (Pervaiz, 2020, p. 4).

Machine learning is defined as the systematic investigation of algorithms and computational models on computers to improve performance or make exact predictions. This is achieved by using experiences that refer to past data on the learner bases a prediction model. This data can be human-labeled digitized files or information obtained via interactions with the surrounding environment (Mohri etal., 2018). It is a subset of AI that originated from pattern recognition. Its major purpose is to analyze data structures and construct models that consumers can understand and use. Machine learning tackles the subject of how to construct a computer program that uses past data to solve specific problems and automatically improves the program's performance via collected experience (Shobha, 2018).

Most businesses, particularly smaller, financially limited businesses, lack the means and influence to engage in costly scope 3 measuring initiatives. In the absence of reporting Scope 3 emissions, a company's portrayal of climate-related financial risk may be incomplete. For instance, a company with substantial upstream Scope 3 emissions, where suppliers wield power, may face future carbon taxes on both Scope 1 and upstream Scope 3 emissions. This is particularly challenging for firms unable to pass costs to customers, especially in industries with low customer switching costs. Similarly, companies with significant downstream scope 3 emissions face heightened technological risks as customers may prefer cost-effective alternatives. Considering limited transparency within numerous enterprises, data providers resort to estimating scope 3 emissions through the application of linear models and heuristics. So, these businesses would benefit from a low-cost, time-efficient solution to the scope 3 measurement dilemma that allows them to develop a rough approximation of their emissions and increase the quality of those measurements over time as resources become available. This estimation is pivotal as it serves to fill the existing informational gaps. In this regard, leveraging machine learning techniques for such estimations could offer notable benefits. ML algorithms effectively utilize variables commonly found in financial statements or disclosed by companies reporting the comparatively simpler Scope 1 and 2 emissions. By making use of the available dataset, these algorithms generate comprehensive reports on Scope 3 emissions. (Serafeim & Velez Caicedo, 2022).

2.4.7 Internet of Thing (IoT)

Internet of Things (IoT) refers to the technologies and devices that enable the fusion of the digital and physical worlds. Sensors, barcodes, RFID tags, and wireless connections are examples of gadgets that continuously record data from their environment. (Christopher, 2023)

In the world of supply chain, IoT plays a pivotal role. It enables the tracking of goods, monitors operations, collects valuable data, and enhances communication with partners. That's why IoT is widely embraced by supply chain companies seeking to improve their processes (De Vass, Shee, & Miah, 2020).

Also, IoT technology presents considerable potential for ESG (Environmental, Social, and Governance) reporting by offering an economical means of gathering, analyzing, and reporting ESG data. IoT's automation and real-time data capabilities not only simplify the data collection process but also boost its precision and efficiency. When combined with AI, IoT brings about profound insights, predictive abilities, and data-informed decision-making, thereby amplifying the effectiveness of ESG strategies. In the future, IoT is set to transform how companies showcase their dedication to sustainable and ethical practices through ESG reporting, fostering greater transparency and accountability (Ystgaard & De Moor, 2022).

2.4.8 Cloud computing

Cloud computing is a software infrastructure that enables companies to storage vast amounts of data gathered from various systems, devices, sensors, and equipment on the internet, often referred to as the cloud. This technology employs software middleware to ensure real-time data access and retrieval. It offers significant advantages, including the capacity to utilize extensive IT resources and store data on remote servers without the need for data center facilities. This streamlined approach reduces the time and effort required by supply chain companies for infrastructure maintenance and enhances overall supply chain visibility. Additionally, cloud computing allows supply chain organizations to centralize logistics and supply chain information, promoting real-time information sharing while eliminating data silos (Seidel, 2022; Partida, 2022).

3. METHOD, DATA AND RESULTS

This chapter of the thesis serves to outline the research methodology, describe the data utilized, outline the research process undertaken, and present the obtained results. The primary objective of the thesis is to delve into the importance of digital tools in Scope 3 reporting. Consequently, the study adopts a qualitative research approach. The qualitative data collection phase aims to gather insights into the challenges and advantages associated with digital tools and their influence on Scope 3 reporting.

3.1 Research strategy

To effectively address the research questions, it is imperative to develop a comprehensive research strategy encompassing various methods and tools relevant to the study. Prioritizing tools and methods that ensure the reliability and validity of the gathered material and data is crucial. Additionally, critical analysis and examination of all collected data are essential.

The research strategy for this thesis commenced with the acquisition and review of background information pertaining to Scope 3 emission reporting in prominent forest companies in Finland. Subsequently, research questions were formulated. Semi-structured interview questions were designed based on the companies' Scope 3 emission reporting practices and utilization of digital tools in this context.

The findings from both primary interviews and secondary data sourced from annual sustainability reports and websites will undergo thorough analysis and discussion to ascertain key insights. Furthermore, conclusions will be drawn based on the outcomes derived from addressing the research questions.

3.2 Data collection

The data collection method employed in this thesis aims to comprehensively understand the challenges and advantages associated with utilizing digital tools for Scope 3 emissions reporting. Given this objective, the empirical study is conducted as qualitative research. Semi-structured interviews serve as the primary approach for qualitative data collection, allowing for in-depth exploration of key themes and insights from the industry. The choice of the semi-structured interview technique is primarily driven by the goal to enable interviewees to freely express their opinions. This approach uses open-ended questions that can be tailored based on the specific characteristics of the firm and the particular challenges they encounter. Darmer (1995) notes that a semi-structured interview is a balance between an informal conversation and a rigid questionnaire.

Qualitative research enhances transparency regarding research results and enables participants to offer fresh viewpoints (Silverman, 2019). Silverman (2019) also states that qualitative approaches help deepen understanding of a subject by incorporating diverse perspectives. Thematic analysis will be employed as the method for discovering and interpreting patterns within the qualitative data gathered.

In addition to the semi-structured interview, public data sources will be utilized to supplement the qualitative findings. This includes extracting information from annual sustainability reports, websites, and other publicly available documents related to current digital solutions for reporting Scope 3 emissions.

The research specifically focuses on forest companies operating in Finland. To ensure a representative sample, three prominent companies in the forestry sector have been selected for the study. Among these companies, one has been chosen for the interview, while information from the websites and annual sustainability reports of all three companies will be analyzed to provide a comprehensive understanding of the digital tools used in Scope 3 emissions reporting within the industry.

3.3 Interview

Candidates for the interview were contacted from the sustainability departments of three prominent forest companies in Finland, which were selected based on their reputation and significance within the industry. A sustainability expert from one company agreed to participate in the interview.

Before the interview, an initial questionnaire was crafted. After several modifications tailored to the research questions, it was finalized, comprising a total of 15 questions divided into three sections: general information, Scope 3 emission reporting, and digital tools.

Table 2. Interview questions

Topic	Question
General	What is your name, title, and how long have you been working in the company?
General	Can you briefly describe your role in the company?
Scope 3 Emission Reporting	Does your company report its Scope 3 emissions separately for each relevant category, and if so, which categories present the most significant challenges for your organization?
Scope 3 Emission Reporting	How critical do you believe effective Scope 3 emission reporting is for your organization and supply chain partners in today's sustainability landscape?
Scope 3 Emission Reporting	What challenges are encountered in executing Scope 3 emission reporting, and how do you address them?
Scope 3 Emission Reporting	Can you explain the methods and sources employed for gathering scope 3 emission data within your organization?
Scope 3 Emission Reporting	Do your suppliers share emission data with your company? If yes, how is the data shared? and what barriers have you encountered in this regard?
Digital Tools	Can you describe the current tools your organization uses for scope 3 reporting?
Digital Tools	Have you integrated or considered any digital tools specifically designed for scope 3 emission reporting? What tools and What criteria were considered in selecting it?
Digital Tools	In which phases of reporting do you employ digital tools for tasks such as collecting data, calculating, and reporting? Or What digital tools would be needed to improve these tasks?
Digital Tools	What benefits do you see from using digital tools in scope 3 emission reporting process?
Digital Tools	What drawbacks or challenges do you see with the adoption of digital tools?
Digital Tools	How do digital tools contribute to ensuring the accuracy and reliability of Scope 3 emission data? Can you provide examples, challenges, or experiences related to this?
Digital Tools	How seamlessly do the digital tools for Scope 3 emission reporting integrate (or can be integrated) with other information systems in your organization?
General	Do you have anything else to add on this topic? E.g., What recommendations do you have for organizations looking to improve their scope 3 emission reporting using digital tools? Are there specific considerations or best practices you would highlight?

3.4 Data analysis

The data analysis for this thesis utilized the thematic analysis approach, a method suitable for examining audio/video interviews, discussions, surveys, and other forms of media. Thematic analysis seeks to identify possible themes and categories, and it aims to present the subject matter along clearly, succinctly, and broadly with a conclusive summary of the research findings (Braun and Clarke, 2012).

Nvivo was utilized for analyzing and transcribing data. During the research process, codes were developed to facilitate data analysis. Coding involved segmenting the results into meaningful and manageable units, which was crucial for the data analysis phase. This process helped prevent the interviewer from disproportionately focusing on any specific aspect of the study, ensuring a comprehensive analysis of the entire interview (Charmaz, 2006).

After the interview was transcribed, the sustainable reports of three companies selected from the forestry sector in Finland were examined. All the important data relevant to the research questions were gathered. One of these companies did not report on Scope 3 emissions, but the information provided in this area was important. The information was coded in NVivo, and although there were many codes initially, they were merged into fewer codes to facilitate a more effective thematic analysis. 13 codes were created as indicated in the table.

Table 3. Initial codes

Code	References
Reporting Challenges	1
Customer	2
Various Material Categories	3
Report Improvement	4
Calculation Model	5
Actions to Address Challenges	8
Strategy and Target	9
Data	11
Significance of Reporting	15

Benefits of Using Digital Tools	15
Directive and Requirement	16
Digital Tools	21
Supplier Collaboration	27

According to the research questions, the research findings are divided into three groups: Directives, Scope 3 emission reporting, and digital tools.

3.5 Results

3.5.1 Directives

In the landscape of corporate sustainability reporting, several key frameworks have emerged as foundational pillars, guiding companies in their efforts to measure and disclose environmental impacts while striving for continuous improvement. These frameworks include the Greenhouse Gas Protocol, Global Reporting Initiative (GRI), Sustainability Accounting Standards Board (SASB), as well as additional initiatives like the Science-Based Targets initiative and the Corporate Sustainability Reporting Directive (CSRD).

The CSRD is a new European Union directive aimed at enhancing sustainability reporting for EU companies. It builds upon existing reporting frameworks and standards, such as the GRI and SASB, to improve the quality, comparability, and reliability of sustainability disclosures. The CSRD expands the scope of reporting requirements, mandating more detailed and standardized disclosures on environmental, social, and governance (ESG) factors. It also introduces requirements for mandatory sustainability reporting by large and listed companies, aiming to provide investors, stakeholders, and policymakers with better insights into companies' sustainability performance and risks.

The Greenhouse Gas Protocol serves as a comprehensive guideline for companies to measure and manage their greenhouse gas emissions. It provides a structured approach to quantifying emissions across scopes, enabling companies to identify emission hotspots and develop targeted reduction strategies.

Similarly, the GRI offers a framework for sustainability reporting that covers a broad range of ESG aspects. By following GRI guidelines, companies can systematically report on their environmental performance, including metrics related to carbon emissions, water usage, biodiversity conservation, and more.

In parallel, the SASB provides industry-specific standards for disclosing financial material sustainability information. These standards help companies identify and prioritize sustainability issues that are most relevant to their industry and stakeholders, ensuring transparency and comparability in reporting practices.

Furthermore, initiatives such as the Science-Based Targets initiative play a crucial role in encouraging companies to set ambitious emissions reduction targets aligned with scientific recommendations. By committing to science-based targets, Companies showcase their dedication to tackling climate change and contributing to global efforts to limit temperature rise to well below 2 degrees Celsius.

Overall, these frameworks and initiatives serve as guiding principles for corporate sustainability reporting, enabling companies to assess their environmental impacts, set meaningful targets, and communicate their progress to stakeholders effectively. By embracing these directives, companies can enhance their environmental performance, build trust with stakeholders, and contribute to a more sustainable future for all.

Table 4. Scope 3 related emission reporting directives

Framework/Initiative	**Description**
Greenhouse Gas Protocol	A comprehensive guideline for measuring and managing greenhouse gas emissions across scopes, aiding in emission reduction strategies.
Global Reporting Initiative (GRI)	Provides a framework for reporting on a broad range of environmental, social, and governance aspects, promoting systematic reporting.
Sustainability Accounting Standards Board (SASB)	Offers industry-specific standards for disclosing financial material sustainability information, ensuring transparency and comparability.
Science-Based Targets initiative	Encourages companies to set ambitious emissions reduction targets aligned with scientific recommendations, aiding climate change mitigation efforts.

Corporate Sustainability Reporting Directive (CSRD)	A new European Union directive aimed at improving the quality, comparability, and reliability of sustainability reporting for EU companies.

3.5.2 Scope 3 emission reporting

Significance of reporting

Scope 3 emission reporting plays a critical role in assessing and addressing an organization's comprehensive environmental impact. While Scopes 1 and 2 primarily focus on direct emissions from owned or controlled sources and indirect emissions from purchased electricity, Scope 3 encompasses a broader spectrum of indirect emissions throughout the entire value chain, including upstream and downstream activities such as supplier emissions, transportation, and product use.

Understanding and quantifying Scope 3 emissions are essential for organizations committed to mitigating their environmental footprint comprehensively. These emissions often constitute a significant portion of an organization's total carbon footprint, especially in industries with extensive supply chains or product lifecycles. By identifying and measuring Scope 3 emissions, organizations can gain insights into their environmental hotspots, enabling informed decision-making and targeted interventions to reduce emissions across the value chain.

Moreover, Scope 3 emission reporting fosters transparency and accountability, both internally and externally. Transparent reporting allows stakeholders, including investors, customers, and regulatory bodies, to assess an organization's environmental performance holistically. It demonstrates a commitment to sustainability and enables stakeholders to make informed choices, driving demand for more environmentally responsible products and services.

Additionally, Scope 3 emission reporting facilitates collaboration and engagement across the value chain. By sharing emission data with suppliers and partners, organizations can identify opportunities for emissions reductions and implement collaborative initiatives to drive collective action. This collaborative approach not only enhances environmental performance but also strengthens relationships and fosters innovation throughout the supply chain.

Table 5. Significance of Scope 3 emission reporting

Benefit	Explanation
Comprehensive Environmental Impact Assessment	Assessing indirect emissions throughout the entire value chain, including upstream and downstream activities such as supplier emissions, transportation, and product use.
Insights for Mitigation Efforts	Identifying environmental hotspots and making informed decisions for targeted interventions, aiming at reducing emissions across the value chain.
Transparency and Accountability	Providing a holistic assessment of environmental performance, demonstrating commitment to sustainability, and enabling stakeholders to make informed choices.
Collaboration and Engagement	Sharing emission data with suppliers and partners to identify opportunities for emissions reductions, implementing collaborative initiatives for collective action, and fostering innovation throughout the supply chain.

Scope 3 emission reporting challenges

The challenges associated with Scope 3 emission reporting for companies are multifaceted and require careful navigation to ensure accurate and reliable data management. These challenges encompass various aspects, including data consolidation and streamlining, calculation model complexity, logistical data management, supplier collaboration and integration of digital tools.

One significant challenge is the complexity involved in consolidating data from diverse sources and material categories. This process requires concerted efforts to streamline and improve reporting mechanisms, ensuring comprehensive coverage across the entire value chain. Additionally, establishing a robust calculation model for emissions presents hurdles, with debates over the use of generic versus supplier-specific emission factors, emphasizing the importance of validated data for accuracy and consistency.

Logistical data management poses another challenge, as companies must manage vast amounts of data while maintaining integrity and alignment with reporting standards. Supplier collaboration for data sharing introduces barriers such as proprietary concerns and varying levels of data availability and accuracy, necessitating clear communication channels and robust validation processes.

Moreover, while digital tools offer benefits in streamlining reporting processes, challenges in adoption include data collection and integration obstacles, manual errors, and inconsistent data sources. Ensuring alignment with organizational data and processes for seamless integration is crucial for effective utilization of these tools.

One of the primary hurdles involves establishing a robust calculation model for emissions. It's crucial to tailor calculation methodologies to specific categories. For instance, chemicals may require supplier-specific emission factors due to variations in product composition and manufacturing processes. An activity-based methodology is employed for scope 3 accounting, involving estimating emissions based on the volumes of inputs sourced and products delivered. Additionally, there is ongoing work to harmonize methodologies and make calculations more accurate. Secondly, when it comes to emissions reductions, one size will not fit all.

The effective management of emissions within supply chains presents a significant challenge for industries across various sectors. Insights gathered from diverse sources underscore the complexities and intricacies involved in this endeavor.

Debates surrounding the utilization of generic emission factors versus supplier-specific ones reveal the nuanced considerations inherent in emission calculation methodologies. Validated data emerges as a crucial factor in ensuring the accuracy and consistency of emissions reporting. Moreover, collaboration with suppliers is identified as essential, highlighting the interdependence of emissions management across the supply chain. The necessity of maintaining confidentiality agreements while engaging closely with suppliers underscores the delicate balance between transparency and proprietary concerns. Companies' emphasis on collaborative action across value chains reflects a recognition of the systemic nature of sustainability challenges. Partnerships and collective efforts are deemed indispensable in driving transformative change across critical sectors. Implementation and enforcement of emission reductions through robust supplier codes of conduct represent concrete steps towards achieving sustainability objectives.

Initiatives aimed at gathering emissions and environmental data from suppliers underscore a commitment to establishing baselines and driving continuous improvement. Standards such as the Supplier Assessment Criteria and industry-wide collaborations like the Together for Sustainability (TfS) initiative exemplify concerted efforts to enhance sustainability practices within supply chains. By gathering comparable data and fostering engagement with suppliers, organizations aim to progress towards the ultimate goal of a carbon-neutral supply chain.

Table 6. Scope 3 emission reporting challenges

Challenges	Description
Data Consolidation and Streamlining	Difficulty in consolidating data from various sources and material categories.
Calculation Model Complexity	Establishing a robust calculation model for emissions, including debate over emission factors.
Logistical Data Management	Managing vast amounts of data effectively, including organizing and updating master data.
Supplier Collaboration and Data Sharing	Collaborating with suppliers for data sharing, overcoming concerns and varying data levels.
Integration of Digital Tools	Challenges in adopting digital tools for data collection and integration across departments.

Actions to address the challenges

In the pursuit of comprehensive sustainability reporting, organizations often encounter a myriad of challenges that can hinder the accuracy, consistency, and transparency of their data. However, rather than succumbing to these obstacles, proactive actions can be taken to address them head-on, ensuring that reporting processes remain robust and reliable.

One key challenge organizations face is the varying levels of maturity in data collection and processing across different categories. To tackle this issue, proactive steps such as streamlining and automating processes are essential. By investing in technologies and systems that enhance efficiency and accuracy, organizations can mitigate disparities in data collection maturity and ensure consistency across all reporting categories.

Another common challenge is the barrier to data sharing, which may arise due to concerns over proprietary information, confidentiality agreements, and discrepancies in data availability and accuracy among suppliers. To overcome these barriers, organizations must establish clear communication channels and implement robust data validation processes. By fostering transparency and trust among stakeholders, organizations can navigate data sharing challenges effectively while upholding the integrity of their reporting practices.

Moreover, collaboration plays a crucial role in addressing reporting challenges. By fostering partnerships with suppliers, industry peers, and relevant stakeholders, organizations can leverage collective expertise and resources to overcome common obstacles. Through collaborative initiatives, such as standardizing reporting frameworks and sharing best practices, organizations can drive continuous improvement in sustainability reporting and enhance industry-wide transparency.

3.5.3 Digital tools

Digital tools are reshaping the landscape of Scope 3 emissions reporting, offering organizations a powerful means to enhance accuracy, efficiency, and transparency in their sustainability efforts.

One key aspect of this transformation is the utilization of Business Intelligence (BI) tools, which serve as centralized platforms for consolidating and analyzing Scope 3 data. These tools empower users to delve into specific categories, such as transportation, facilitating detailed analysis and informed decision-making. Additionally, automation plays a pivotal role, streamlining data collection, calculation, and reporting processes. By automatically extracting data from ERP systems and applying predefined rules and emission factors, organizations ensure data integrity while minimizing manual effort and errors.

Integration with ERP systems further amplifies the efficiency of emissions reporting, enabling real-time data processing and automatic calculation of emissions. This integration ensures seamless data management and facilitates streamlined reporting processes. Moreover, structured data management and visualization are paramount, as digital tools enable stakeholders to gain visibility into emissions data and identify areas for improvement effectively.

Furthermore, collaboration with industry initiatives and the adoption of shared reporting practices are essential components of leveraging digital solutions for emissions reporting. These efforts promote the use of credible standards and facilitate the exchange of comparable primary supply chain data, thereby enhancing the accuracy, reliability, and efficiency of emissions reporting throughout the value chain.

In summary, digital tools play a crucial role in bridging gaps in Scope 3 emissions reporting, enabling organizations to advance their sustainability goals effectively. With benefits ranging from improved accuracy and efficiency to enhanced transparency and decision-making, these tools empower organizations to navigate the complexities of emissions management and work towards achieving their environmental objectives.

4.DISCUSSION

4.1 The evolution of sustainability reporting directives

When considering research question 1 (RQ1) regarding upcoming reporting mandates for Scope 3 emissions in the supply chain, it is essential to delve into the regulatory framework, focusing particularly on the initiatives and directives of the European Union.

The EU has been a pioneer in sustainability reporting, witnessing significant advancements in regulatory frameworks aimed at bolstering transparency and accountability. This analysis begins by tracing the evolution of sustainability reporting regulations, from the inception of the NFRD to the more recent CSRD (EFRAG, 2021).

The CSRD is a novel European Union directive aimed at enhancing sustainability reporting for EU companies. It builds upon existing reporting frameworks and standards, such as the GRI and SASB, to improve the quality, comparability, and reliability of sustainability disclosures. The CSRD expands the scope of reporting requirements, mandating more detailed and standardized disclosures on ESG factors. It also introduces requirements for mandatory sustainability reporting by large and listed companies, aiming to provide investors, stakeholders, and policymakers with better insights into companies' sustainability performance and risks (European Commission, 2023).

Furthermore, in the landscape of corporate sustainability reporting, several key frameworks have emerged as foundational pillars, guiding companies in their efforts to measure and disclose environmental impacts while striving for continuous improvement. These frameworks include the Greenhouse Gas Protocol, which serves as a comprehensive guideline for companies to measure and manage their greenhouse gas emissions. It provides a structured approach to quantifying emissions across scopes, enabling companies to identify emission hotspots and develop targeted reduction strategies (European Commission, 2023).

Similarly, the GRI offers a framework for sustainability reporting that covers a broad range of ESG aspects. By following GRI guidelines, companies can systematically report on their environmental performance, including metrics related to carbon emissions, water usage, biodiversity conservation, and more.

In parallel, SASB provides industry-specific standards for disclosing financial material sustainability information. These standards help companies identify and prioritize sustainability issues that are most relevant to their industry and stakeholders, ensuring transparency and comparability in reporting practices.

Furthermore, initiatives such as the Science-Based Targets initiative play a crucial role in encouraging companies to set ambitious emissions reduction targets aligned with scientific recommendations. By committing to science-based targets, companies demonstrate their commitment to addressing climate change and contributing to global efforts to limit temperature rise to well below 2 degrees Celsius (UN, 2023).

Overall, these frameworks and initiatives serve as guiding principles for corporate sustainability reporting, enabling companies to assess their environmental impacts, set meaningful targets, and communicate their progress to stakeholders effectively. By embracing these directives and frameworks, companies can enhance their environmental performance, build trust with stakeholders, and contribute to a more sustainable future for all.

4.2 Understanding challenges in Scope 3 emission reporting

The discussion concerning the challenges of Scope 3 emission reporting for companies (RQ2) is critical in understanding the complexities and barriers faced in achieving accurate and reliable sustainability disclosures. Drawing upon both empirical findings and existing literature, we can discern the multifaceted nature of these challenges and their implications for corporate environmental reporting practices.

The empirical findings underscore several key challenges inherent in Scope 3 emission reporting. Data consolidation emerges as a significant hurdle, with companies grappling with the complexity of integrating data from diverse sources and material categories across their value chains. This process necessitates concerted efforts to streamline reporting mechanisms and ensure comprehensive coverage, highlighting the importance of robust data management practices.

Moreover, the complexity of calculation models presents another formidable challenge. Debates over the utilization of generic versus supplier-specific emission factors underscore the nuanced considerations involved in emission accounting methodologies.

Validated data becomes paramount in ensuring accuracy and consistency in emissions reporting, emphasizing the need for standardized approaches and transparent validation processes.

Logistical data management poses additional challenges, with companies managing vast amounts of data while maintaining alignment with reporting standards. Supplier collaboration introduces complexities such as proprietary concerns and varying levels of data availability and accuracy, necessitating clear communication channels and robust validation procedures to ensure data integrity.

The integration of digital tools offers potential benefits in streamlining reporting processes; however, challenges in adoption, such as data collection and integration obstacles, underscore the importance of aligning these tools with organizational data and processes for effective utilization.

These findings are corroborated by existing literature, which identifies similar challenges and nuances in Scope 3 emission reporting. Limited data transparency and low data quality are identified as barriers, emphasizing the critical role of validated data in ensuring the reliability of emission disclosures (CDP, 2023). The challenge of multiple counting emissions further complicates reporting precision, highlighting the need for clarity and consistency in emission accounting methodologies (Patchell, 2018).

Moreover, the issue of comparability between companies underscores the importance of standardized approaches and methodologies to facilitate effective benchmarking and progress tracking. Variations in methodologies and emission factors utilized by different organizations hinder comparability and trackability, underscoring the need for harmonization efforts and standardized reporting frameworks.

Scope 3 emissions reporting is acknowledged to be a difficult and expensive task, particularly for small and medium-sized businesses lacking the resources required for full sustainability reporting (McKinnon, 2004) Challenges on the supplier side, including a lack of time, interest, and knowledge in environmental management, further compound the complexities of Scope 3 emission reporting, necessitating collaborative efforts and industry-wide initiatives to address these barriers (Lee & Klassen, 2008).

4.3 Transformative role of digital tools in enhancing Scope 3 emissions reporting

In addressing RQ3, which delves into the transformative impact of digital tools on Scope 3 emissions reporting within supply chains, the exploration draws insights from both literature and empirical findings.

The literature underscores the pivotal role of digital tools in reshaping the landscape of emissions reporting, particularly highlighting their ability to enhance accuracy, efficiency, and transparency in sustainability efforts. This sets the stage for understanding the practical implications of integrating digital solutions into emissions reporting processes (Buchholz, 2023).

Empirical findings corroborate these assertions, shedding light on specific aspects of digital tools' utilization in emissions reporting. One key finding centers around the utilization of Business Intelligence (BI) tools as centralized platforms for consolidating and analyzing Scope 3 data. Through BI tools, organizations gain the capacity to conduct detailed analyses, particularly in specific emission categories like transportation, thereby bolstering the accuracy and effectiveness of reporting efforts.

Automation emerges as another crucial facet, as evidenced by empirical research. By automating data collection, calculation, and reporting processes, organizations can ensure data integrity while minimizing manual effort and errors. Integration with ERP systems further augments efficiency, enabling real-time data processing and automatic emission calculations. Such integration not only streamlines reporting processes but also ensures seamless data management across the organization.

Structured data management and visualization emerge as imperative components in the utilization of digital tools for emissions reporting. Empirical insights emphasize how these tools enable stakeholders to gain comprehensive visibility into emissions data, facilitating informed decision-making and strategic planning. Through structured data management and visualization, organizations can identify emission hotspots, track progress, and optimize sustainability strategies effectively.

In conclusion, the integration of digital tools offers organizations unprecedented capabilities to transform Scope 3 emissions reporting within supply chains. By leveraging BI tools, automation, ERP integration, and structured data management, companies can enhance the accuracy, efficiency, and transparency of their emissions reporting processes. These findings underscore the significance of embracing digital solutions to navigate the complexities of emissions management and drive progress towards environmental sustainability objectives.

4.4 Reliability and validity of the study

The reliability and validity of any research study are pivotal in ensuring the credibility and trustworthiness of its findings. In the context of this thesis, which investigates the utilization of digital tools in Scope 3 emission reporting, adherence to rigorous standards of reliability and validity is imperative to uphold the integrity of the research outcomes.

Reliability, characterized by the consistency and stability of data collected over time, and validity, focusing on the accuracy and relevance of the research questions being addressed, are foundational principles in qualitative research methodologies (Creswell, 2014). To ensure the reliability of the qualitative data collected in this study, measures such as triangulation of data sources have been implemented, aligning with established best practices (Maxwell, 2013). These techniques not only promote consistency in interpretation across different analysts but also validate the findings through the convergence of multiple data streams.

Furthermore, the integration of established and validated research instruments and techniques has bolstered the reliability and validity of the study. Expert reviewers and peer debriefing sessions have been used in refining the research process and validating interpretations drawn from the data, in accordance with scholarly recommendations (Maxwell, 2013).

In terms of validity, efforts have been made to confirm the appropriateness of operational measures for the concepts under study. Techniques such as triangulation and peer debriefing have been employed to fortify the validity of the findings (Rezapour Nasrabad, 2018; Evans, 2017). Through these methodologies, the study aims to ensure that its outcomes accurately reflect the phenomena under investigation.

Considerations of external validity have also been addressed by providing descriptions of the research context. This approach enhances the transferability of the findings to analogous contexts and enriches the applicability of the study's outcomes (Kessler and Vesterlund, 2015; Wong, 2008).

While diligent efforts have been made to enhance the reliability and validity of this study, it is important to acknowledge the inherent subjectivity and context-dependence of qualitative research. In addition, only three companies were studied and only one expert was interviewed. Therefore, while the findings offer valuable insights, their interpretation should be approached with discernment, and future research endeavors may benefit from further validation and replication across diverse settings.

5.CONCLUSIONS

This thesis contributes to the understanding of Scope 3 emission reporting, its challenges, and the role of digital tools in improving reporting. By examining the intersection of regulatory requirements, reporting challenges, and digital solutions, this study aims to provide valuable insights for industrial companies. Forest companies, in particular, face unique challenges in measuring and reporting their environmental impacts, especially concerning Scope 3 emissions originating from activities outside their direct control. The study strives to generate new knowledge on the topic to enhance their environmental reporting practices and contribute to a more sustainable future.

The main forthcoming regulation concerning Scope 3 emissions is outlined in the CSRD, established by the European Union in alignment with the climate objectives of the Paris Agreement and the European Green Deal. The CSRD mandates reporting standards that are delineated in the ESRS, which provide meticulous guidelines for Scope 3 emissions, including provisions for third-party verification. This directive underscores the EU's commitment to fostering transparency and accountability in environmental disclosures, compelling organizations to adhere to rigorous reporting standards.

Companies in the process of calculating and reporting face different challenges. These challenges, as highlighted through the examination of forest companies in Finland, encompass complexities in data consolidation, calculation models, supplier collaboration, data sharing, and logistical hurdles. Additionally, the process can pose significant burdens, especially for smaller businesses lacking resources for comprehensive sustainability reporting. Challenges on the supplier side, such as lack of time and interest, and varying levels of expertise in environmental management, further accentuate the complexities of Scope 3 emission reporting, underscoring the necessity for collaborative efforts and industry-wide initiatives to overcome these barriers.

However, amidst these challenges, digital solutions offer promising avenues for progress. Business Intelligence (BI) tools, automation, and structured data management emerge as transformative elements, streamlining reporting processes, enhancing data accuracy, and fostering transparency through reducing manual effort and errors, enabling real-time data processing and automatic calculations, and providing comprehensive visibility into data, thereby facilitating informed decision-making and strategic planning. By leveraging these digital tools, companies can delve deeper into their emissions profiles, pinpoint areas for improvement, and refine sustainability strategies within their supply chains. Embracing digital solutions is imperative for effectively navigating the complexities of Scope 3 emission reporting, where collaboration among stakeholders and ongoing innovation in digital technologies play pivotal roles in driving progress towards environmental sustainability objectives. Through the strategic deployment of digital tools, organizations not only meet regulatory mandates but also contribute significantly to building a more sustainable future for our planet.

Future research in this area could delve deeper into several aspects related to Scope 3 emission reporting and the utilization of digital tools in sustainability disclosures. Exploring the effectiveness of specific digital solutions in addressing the challenges identified in this study, such as data consolidation complexities and supplier collaboration issues, could offer valuable insights for companies seeking to optimize their reporting processes. Furthermore, future research could focus on the development of standardized methodologies or best practices for Scope 3 emission accounting, considering the diverse nature of supply chains and the complexities associated with indirect emissions. Investigating the integration of emerging technologies, such as blockchain or artificial intelligence, in Scope 3 reporting systems could also present opportunities to enhance data accuracy, transparency, and accountability. Moreover, examining the impact of Scope 3 emission reporting on stakeholders, including investors, consumers, and regulatory bodies, could provide a comprehensive understanding of the broader implications of sustainability disclosures.

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