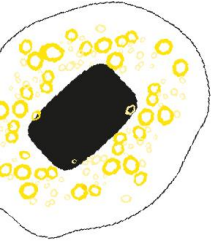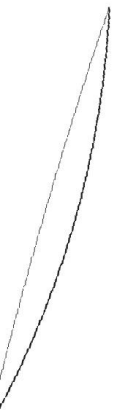**UNIVERSITY OF TWENTE.**

# Exploring the Risks and Opportunities of Information Technology in Environmental, Social and Governance Reporting

*Master Thesis*

*Submitted by:*
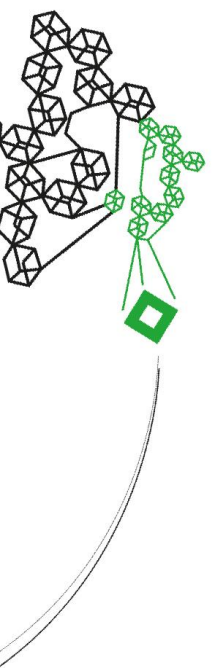
*Cas Smit*

*S31604671*


*Supervisors University of Twente:*

*1st: Dr. Vincent Göttel*

*2nd: Dr. Michel Ehrenhard*

*Wordcount: 19643*


*30 June 2025*

# Abstract

The introduction of the Corporate Sustainability Reporting Directive (CSRD) marks a significant expansion in Environmental, Social and Governance (ESG) reporting requirements for organizations across the European Union. As a result, organizations are under increasing pressure to ensure that their ESG-data is accurate, complete, and reliable. This study investigates how data gathering technologies, specifically Enterprise Resource Planning (ERP) systems and Internet of Things (IoT) devices, contribute to or hinder this goal, and how these technologies are currently evaluated within ESG assurance practices.

A qualitative research design was used, applying the Gioia methodology to analyze fifteen semi-structured interviews with ESG and IT audit professionals. The aim was to gain in-depth, practice-based insights into the state of technological integration in ESG reporting and assurance.

The findings of the study reveal that while ERP systems offer promising functionalities for structuring and standardizing ESG-data, their potential remains largely underused. IoT technologies are scarcely implemented in ESG reporting, especially outside emission-intensive sectors. Risks were mainly associated with the absence or immaturity of data gathering technologies, including manual data handling, system fragmentation, and weak control environments in ESG reporting. Furthermore, assurance practices in ESG reporting still rely heavily on plausibility checks, with minimal formal involvements of IT auditors, partly due to the CSRD's continued emphasis on limited assurance, as reaffirmed in the Omnibus Proposal.

This study concludes that improving ESG reporting under the CSRD is not solely a technological challenge, but also an organizational and regulatory one. This includes the need for clearer regulatory expectations, better integration of ESG reporting needs within IT infrastructures, and a more defined role for IT auditors in supporting the reliability and assurance of ESG disclosures. Without such changes, the transformative potential of Information Technology in ESG reporting is unlikely to be fully realized.

# Acknowledgements

I would like to express my sincere gratitude to my supervisor, Dr. Göttel, for his valuable guidance, constructive feedback, and encouragement throughout the writing process.

Furthermore, I would like to thank all respondents who contributed their time and expertise during the research phase. Their input was essential in shaping the empirical depth of this thesis. I look back on this period with appreciation and pride.

# Table of Contents

# 1 Introduction

In recent years, sustainability has become a critical focus for business, driven by growing societal expectations and shifting perspectives on corporate sustainability (Zumente & Bistrova, 2021). In the past, corporations' focus was on short-term profitability, as suggested by the shareholder theory (Friedman, 1970). Recently, this focus has heavily shifted towards the more sustainable, long-term-oriented version of value creation, as described by the stakeholder theory (Freeman, 2015). There is an increasing pressure from stakeholders to address Environmental, Social, and Governance (ESG) issues to become more sustainable (Sharma, 2022). This shift reflects a broader societal demand for transparency, accountability, and long-term value creation.

The growing interest in a company's sustainability strategy and performance has made financial information alone insufficient to meet stakeholders' needs in corporate disclosures(Fischer et al., 2023). Numerous regulations have been introduced to promote and guide the transition toward sustainability through the implementation of sustainability reporting. The Corporate Sustainability Reporting Directive (CSRD) is a leading example of this effort (AFM, 2023). In the past, ESG reporting was voluntary, however, with the introduction of the CSRD, ESG reporting became mandatory for large public-interest entities (PIEs) with over 500 employees as of 2024, increasing the need for accuracy, completeness, and reliability of ESG-data. From 2025, the requirements will apply to all large companies meeting at least two of the following criteria: 250 or more employees, €40M+ turnover, or €20M+ in assets. By 2026, small and medium-sized listed enterprises (SMEs) must comply, and by 2028, non-EU companies with €150M+ EU turnover will also be included (AFM, 2023).

The CSRD has recently been introduced as part of the European Union's commitment to more robust and standardized sustainability reporting (Noonan, 2021). At the heart of the CSRD is the requirement for companies to adhere to the European Sustainability Reporting Standards (ESRS), a detailed framework designed to ensure consistent and reliable non-financial reporting (AFM, 2023). The ESRSs provide comprehensive guidelines for sustainability reporting, categorized into three specific categories, Environmental, Social, and Governance (ESG). The reporting on these categories relies on over a thousand data points, e.g. climate change, pollution, and workers in the value chain as topics to report on (EFRAG, 2024; EU, 2022; EY, 2024b).

As a result, the CSRD mandates companies to disclose a broader range of information using standardized reporting requirements, enabling comparability and assessment across organizations. A key element of the CSRD is the introduction of third-party assurance providers, who are required to evaluate and verify the sustainability reports of in-scope companies to provide assurance over the reported information (Bakarich et al., 2022; EU, 2022; Primec & Belak, 2022). These third-party assurance providers are typically audit and assurance practitioners from large accountancy and

advisory firms, most notably the Big Four (EY, PwC, Deloitte, and KPMG). While these firms have traditionally focused on financial reporting, they are now expanding their scope to include assurance over ESG disclosures under the CSRD.

In the initial phase of the CSRD, companies are only required to obtain limited assurance on their sustainability reports, with reasonable assurance becoming mandatory starting in 2028 (EU, 2022; Ruohonen & Kullas, 2024). Limited assurance offers a relatively lower level of scrutiny, while reasonable assurance provides a more rigorous evaluation of the data, generally aiming to provide a level of confidence of 95% that the information is reliable (Benameur et al., 2024; Sphera, 2024). The shift toward mandatory and standardized sustainability reporting, combined with the growing involvement of professional auditors to provide assurance, represents a significant development in enhancing the reliability and credibility of reported sustainability information. Furthermore, the requirement for third-party assurance over ESG-data necessitates a more thorough understanding of how this data is being collected, analyzed, and managed. This poses challenges, not only for companies subject to the CSRD but also for third-party assurance providers, who need to develop a deeper understanding of ESG reporting processes to be abled to provide assurance (Sonnerfeldt & Pontoppidan, 2020). At the same time, it influences how organizations manage sustainability information internally, driving improvements in accuracy, completeness, and overall reliability (Bakarich et al., 2022).

Forming a thorough understanding of processes involved in gathering, analyzing, and managing ESG-data, to be able to provide assurance, is a complex challenge. The landscape of ESG reporting is constantly evolving, driven by emerging regulations, as well as technologies, with the CSRD adding momentum to this transformation (Markova-Karpuzova et al., 2024). With the implementation of the CSRD, the EU is pushing for the addition of sustainability performance as a comparable metric for corporate performance, therefore a demand is being created for ways to optimize the ESG-data handling process (Feroz et al., 2021; Svensson, 2023).

The ESRSs, being part of the CSRD, encompass more than a thousand data points, including, for example, emissions and energy consumption. Recent studies have shown that the emergence of these more comprehensive regulations on ESG reporting are creating a pressing need for advanced tooling and technologies to handle the increased complexity and volume of ESG-data (Markova-Karpuzova et al., 2024). Mainly due to the scale and complexity of the requirements, the use of advanced IT systems is inevitable (EY, 2024b). Recent studies show that tools and technologies, specifically Internet of Things (IoT) devices and Enterprise Resource Planning (ERP) systems, are already being utilized to monitor and manage ESG-data, such as emissions information. These technologies have proven effective in enhancing the accuracy and transparency of sustainability reporting (Lauzzana, 2023; Schmidt et al., 2022). As the complexity of ESG reporting grows, and regulatory expectations continue

to evolve, these technologies, and IT in general, will likely play an increasingly central role in ensuring compliance and facilitating efficient ESG-data management (Hummen & Jobst, 2024; Markova-Karpuzova et al., 2024; Vărzaru, 2022).

While exploring the topic in practice, it became evident that both ERP and IoT systems are not only increasingly deployed but are also regarded as highly relevant for practitioners involved in ESG assurance. Literature reinforces this perspective, highlighting their growing importance in capturing structured and timely ESG-data (Lauzzana, 2023; Schmidt et al., 2022). ERP systems are widely used in organizations and are central to IT auditors' current work, ERP systems serve as a central platform for integrating data from various business functions, ensuring structured and traceable reporting (Darius Dudek, 2024). Given that ERP systems already play a central role in financial reporting by enabling standardized and traceable data flows, their expected integration into ESG reporting makes it highly relevant to examine how these systems can offer both opportunities and risks in this new context. IoT devices, on the other hand, represent an emerging and rapidly growing technology that enables automated, real-time ESG-data collection, such as energy consumption, emissions tracking, and environmental monitoring (Lauzzana, 2023). As IoT is still relatively new in the context of ESG reporting, it also introduces both significant opportunities and risks, making it a highly relevant area of study for IT auditors, assurance providers, and other stakeholders involved in ESG reporting under the CSRD."

Although IT is already being applied in ESG reporting and its importance is expected to grow, its precise role in this context remains insufficiently defined. This lack of clarity poses significant challenges for assurance providers to determine how IT systems influence the reliability of ESG-data, posing a barrier to consistent and effective assurance practices. This stands in contrast to financial reporting, where examining an organization's IT infrastructure, applications, and processes is a well-established and essential part of the assurance process, typically carried out by IT auditors (Gupta & Sharman, 2023). The use of IT can significantly impact the quality aspects of data while also introducing notable risks. When it comes to ESG reporting under the CSRD, these risks not only result in non-compliance with CSRD requirements but can also result in reputational damage, financial penalties, and reduced stakeholder trust, with greenwashing being a prominent example of how such consequences can arise (Amran et al., 2024).

## 1.1 Relevance

As organizations face growing regulatory demands for ESG reporting, the need for advanced information technology to effectively gather, manage, and verify ESG-data is becoming critical. Recent studies highlight that integrated IT solutions are essential to manage the growing complexity and volume of ESG-data, particularly technologies such as ERP systems and Internet of Things (IoT) device, to ensure accuracy, completeness, and traceability (Lauzzana, 2023; Markova-Karpuzova et

al., 2024). In parallel, the CSRD introduces mandatory assurance requirements, with limited assurance required in the initial phase and reasonable assurance mandated by 2028. This regulatory shift reinforces the importance of understanding the technologies underpinning ESG disclosures, not only in terms of their potential to enhance the reliability and verifiability of reported information, but also with regard to the risks they may introduce. Despite these developments, opportunities, and associated risks of using IT in ESG reporting remain underexplored. While it is acknowledged that IT will play an increasingly significant role, there is still limited clarity on how specific technologies contribute to ESG reporting processes and where they may introduce weaknesses.

**Scientific relevance**

This study intends to contribute to the growing body of literature on digitalization in ESG reporting. While the importance of ESG disclosures has gained significant academic attention (Bakarich et al., 2022; Dragomir et al., 2024; Primec & Belak, 2022), the integration of information technologies in this context, particularly in relation to assurance, has not been thoroughly examined. Most existing research focuses either on the content of ESG reports, or on regulatory developments (EuropeanCommission, 2025; Ruohonen & Kullas, 2024), leaving a gap regarding the technologies underpinning ESG-data collection and evaluation.

The study addresses the gap by exploring how data gathering technologies, specifically ERP systems and IoT devices, can influence the reliability and auditability of ESG disclosures. Prior research highlights the potential of these technologies in a more operational context (Markova-Karpuzova et al., 2024), but the risks and opportunities it introduces in the context of assurance in ESG reporting remains largely unexplored. Moreover, the role of IT auditors in ESG assurance is rarely addressed in academic work, despite its growing relevance under regulations such as the CSRD (Ruohonen & Kullas, 2024). Therefore, this study contributes to the theoretical understanding of how data gathering technologies can enhance the reliability and auditability of ESG disclosures. In doing so, it provides a foundation for future research on assurance approaches in the context of ESG reporting.

**Practical relevance**

While previous literature acknowledges the practical application of data gathering technologies in ESG reporting, structured guidance on how to evaluate and audit these technologies remains limited. To address this gap, this study explores the opportunities and risks of implementing ERP systems and IoT devices as data gathering technologies within the context of ESG reporting under the CSRD. The lack of clear evaluation criteria for how assurance providers should assess these technologies presents a significant challenge. At the same time, the study offers practical insights for organizations looking to enhance their ESG-data gathering processes and comply with emerging regulatory expectations more effectively.

As organizations become increasingly reliant on digital infrastructures to meet CSRD requirements, understanding how technologies such as ERP systems and IoT devices can support the integrity, traceability, and auditability of ESG-data becomes critical, not only for assurance professionals, but also for reporting entities themselves. This study provides practical recommendations for assurance providers, and organizations subject to the CSRD. These insights aim to help stakeholders navigate the challenges of ESG reporting more effectively, particularly as it becomes increasingly data driven and dependent on technology.

## 1.2 Research Goal & Question

The goal of this study is to explore the opportunities that data gathering technologies, specifically ERP systems and IoT devices, offer in enhancing the accuracy, completeness, and reliability of ESG-data required for CSRD compliance. Additionally, this research aims to identify the risks associated with these technologies in the ESG reporting process. Given the CSRD's assurance requirements, the study further aims to examine how these technologies are evaluated in current ESG assurance practices and how assurance practices can evolve in the ESG domain. To achieve this, the following main research question and research sub-questions have been established.

**Main research question**

What are the opportunities and risks of data gathering technologies, specifically ERP systems and IoT devices, in ensuring the accuracy, completeness, and reliability of ESG-data for compliance with the Corporate Sustainability Reporting Directive (CSRD)?

**Sub-questions**

1. What is the current state of data gathering technologies in ESG reporting practices?
2. What are the main risks of using data gathering technologies in ESG reporting under the CSRD?
3. What opportunities do data gathering technologies offer to improve ESG-data under the CSRD?
4. How are data gathering technologies currently assessed in ESG assurance, and how can IT- and ESG auditors coordinate their approaches in the future?

The first sub-question is essential for a comprehensive understanding of the current state of data gathering technologies, specifically ERP systems and IoT devices, in ESG reporting practices. This provides a foundation by clarifying how and to what extent these technologies are already being utilized. The second sub-question focuses on identifying the main risks associated with the use of such technologies in the context of ESG-data. Identifying these risks provides crucial context for the remainder of the study, as it clarifies potential weaknesses that must be addressed before meaningful opportunities can be explored. This approach ensures a logical progression toward understanding the

potential added value of these technologies. Building on this, the third sub-question explores the opportunities data gathering technologies can offer to enhance the reliability, traceability, and completeness of ESG-data which are key elements for CSRD compliance. At last, the fourth sub-question focusses on the assurance process, examining how data gathering technologies are currently assessed and how IT and ESG auditors can better coordinate their approaches in light of future assurance demands.

## 1.3 Structure

The thesis is structured into different chapters, as follows. The first chapter consists of the *Literature review*, which describes earlier investigations on the different topics and highlights the relevance of this research. The second chapter presents the *Methodology*, which outlines the research design and explains how validity and reliability will be ensured through the research. The fourth chapter shows the *Results* after data collection has been completed, aiming to answer the research questions. At last, the last chapter includes the *Conclusion and Discussion*, as well as any implications remaining from the research.

# 2 Literature review

To contextualize this study, the literature review is structured around four interrelated themes. First, it explores the evolution from Corporate Social Responsibility (CSR) to Environmental, Social and Governance (ESG) reporting, clarifying key conceptual distinctions and the growing regulatory landscape. Since sustainability is increasingly being operationalized through measurable ESG criteria, this literature review consistently refers to ESG reporting as the primary framework through which corporate sustainability is disclosed and assessed. Second, the literature review examines the role of the Corporate Sustainability Reporting Directive (CSRD), including its scope, reporting requirements, and the emergence of mandatory assurance. Furthermore, the review addresses the increasing relevance of information technology in ESG-data collection and reporting, with a focus on Enterprise Resource Planning (ERP) systems and Internet of Things (IoT) devices. At last, the role of IT auditors in ESG assurance is discussed, with attention to emerging challenges, current gaps in practice, and the potential for integrated assurance approaches. Together, these themes establish the theoretical foundation and relevance for investigating how data gathering technologies affect the reliability of ESG reporting under the CSRD. In doing so, the literature review not only synthesizes existing knowledge but also identifies critical gaps, particularly around the use and auditing of data gathering technologies in ESG reporting, that this study seeks to address.

## 2.1 ESG Reporting: Emergence and Regulatory Development

In recent years, sustainability has evolved into a strategic priority for organizations, driven by driven by heightened stakeholder expectations and growing societal demands (Zumente & Bistrova, 2021). In today's practice, a prominent framework for assessing corporate sustainability is Environmental, Social, and Governance (ESG), which provides a structured approach to evaluate how companies address non-financial performance indicators  (Iamandi et al., 2019; Zhang et al., 2024). ESG serves as an operationalization of Corporate Social Responsibility (CSR), with the former increasingly recognized as a measurable and reportable construct guiding investment and compliance decisions (Prakash, 2020).

The ESG framework consists of three dimensions. The environmental dimension refers to a company's approach to climate change, pollution, and resource consumption. The social dimension includes human rights, diversity, and employee relations. Governance encompasses leadership structures, ethical conduct, and corporate accountability mechanisms (Armstrong, 2020). Transparency in the different areas has become essential as companies face increasing pressure to disclose sustainability performance in addition to financial results (Markova-Karpuzova et al., 2024; Pollman, 2022).

ESG reporting provides stakeholders with insights into topics not typically covered in financial statements, such as greenhouse gas emissions, community impact, and ethical governance (Aggarwal & Singh, 2019). Although ESG reporting seems recently new, it is rooted in decades of evolving

corporate responsibility practices. CSR can be traced back to the 19th century, gaining traction in the 1950s through seminal work by Bowen (1953), who argued that businesses have social obligations beyond profit maximization. Throughout the 1970s and 1980s, CSR gained structure, with growing focus on ethical responsibilities and stakeholder interests (Carroll, 2008; Primec & Belak, 2022). This evolution laid the conceptual groundwork for ESG reporting, eventually transitioning from voluntary commitments to more formalized disclosure obligations (Pollman, 2022).

As the demand for transparency in ESG reporting increased, the regulatory landscape evolved accordingly. Particularly in the European Union, a sequence of legislative developments has shaped the current ESG reporting framework. An overview of the key EU directives is presented in figure 1.
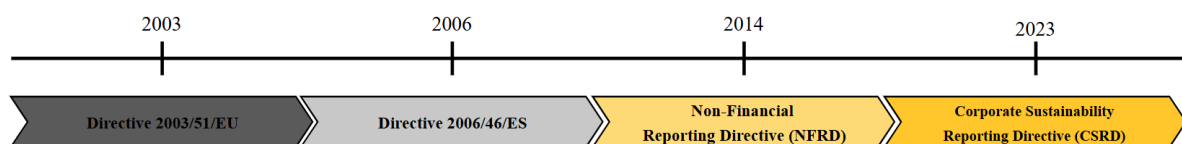


*Figure 1: Overview of the emerging regulations around ESG reporting*

The development of EU legislation on sustainability, as seen in figure 1, has progressively emphasized greater transparency and accountability. The Directive 2003/51/EU laid the first step by recommending to report on environmental and social aspects in addition to financial information while allowing smaller companies to be exempted to minimize burdens (EU, 2003). In 2006, Directive 2006/46/ES introduced mandatory corporate governance statements to rebuild confidence in financial reporting after major corporate scandals. This directive also emphasized management accountability and aimed to provide stakeholders with better insights into governance practices (EU, 2006). The Non-financial Reporting Directive (NFRD) expanded these requirements by obligating large Public-Interest Entities (PIEs) to disclose non-financial information, including ESG factors, through a diversity policy and a dedicated non-financial statement (EU, 2014). Most recently, the Corporate Sustainability Reporting Directive (CSRD) significantly extended these requirements, introducing mandatory ESG reporting for a broader group of companies, standardization through the European Sustainability Reporting Standards (ESRS), and assurance requirements to strengthen reliability and comparability of sustainability data (AFM, 2023; EU, 2022; Primec & Belak, 2022).

## 2.2 The Corporate Sustainability Reporting Directive (CSRD)

The CSRD is the most recent development in EU legislation on sustainability reporting, as illustrated in figure 1. It is built based on its predecessor, the NFRD (Baumuller & Grbenic, 2021). While the NFRD marked a first step toward mandatory non-financial disclosures, it left considerable discretion to companies in how and what to report. In response to its limitations, particularly its lack of standardized reporting frameworks, the European Commission committed to revising it under the

European Green Deal of 2019 (Baumuller & Grbenic, 2021; Noonan, 2021).  This led to the formal adoption of the CSRD (AFM, 2023).

The CSRD introduces several significant new elements to sustainability reporting. To begin with, the CSRD expands the scope of sustainability reporting, requiring more detailed, comparable, and reliable information (Hummel & Bauernhofer, 2024; Primec & Belak, 2022). Starting in 2024, the CSRD requires large PIEs with over 500 employees to report under its framework. From 2025, the scope expands to include all large companies meeting at least two of the following criteria: over 250 employees, a net turnover exceeding €40 million, or total assets above €20 million. By 2026, small and medium-sized listed enterprises will also be required to comply with the CSRD. At last, by 2028, non-EU companies generating more than €150 million in net turnover within the EU will fall under the directive (AFM, 2023).

A central innovation of the CSRD is the double materiality principle, which obliges firms to report not only how sustainability risks impact their financial performance, but also how their operations affect people and the plane (Dragomir et al., 2024). This dual perspective significantly broadens the required disclosures, compelling firms to address topics such as greenhouse gas emissions, biodiversity impacts, labor conditions, and governance practices (Dathe et al., 2024).

To facilitate consistent and comparable reporting, companies must use the European Sustainability Reporting Standards (ESRS), developed by the European Financial Reporting Advisory Group (EFRAG) (EU, 2022). These standards cover 12 key topics, each encompassing numerous granular data points (EFRAG, 2023).  Figure 2 provides an overview of these 12 ESRS categories (EFRAG, 2024; EU, 2022; EY, 2024b).

| Cross-Cutting Standards | Topical sector-agnostig Standards | | |
|---|---|---|---|
| ESRS 1 General Requirements | Environmental | Social | Governance |
| ESRS 2 General Disclousres | ESRS E1 Climate Change | ESRS S1 Own workforce | ESRS G1 Business conduct |
| | ESRS E2 Pollution | ESRS S2 Workers in the value chain | |
| | ESRS E3 Water and marine resources | ESRS S3 Affected communities | |
| | ESRS E4 Biodiversity and ecosystems | ESRS S4 Consumers and end-users | |
| | ESRS E5 Resource use and circular economy | | |

*Figure 2: Overview of the twelve ESRSs topics*

Each ESRS topic contains detailed metrics. For example, in ESRS E1, the climate change section, companies are required to report precise metrics such as Scope 1,2, and 3 greenhouse gas emissions, energy intensity, and targets for reducing carbon footprints. Similarly, social standards such as S1 demand insights into workforce diversity, employee turnover, and equal pay (EFRAG, 2023). These data points are designed to improve data quality, transparency, and comparability across reporting entities (Primec & Belak, 2022).

At last, the CSRD introduces a mandatory assurance requirement over ESG disclosures (AFM, 2023; EU, 2022). Unlike the NFRD, the CSRD requires third-party verification of reported information, initially through limited assurance, with a future shift toward reasonable assurance. This obligation ensures that reported ESG-data is not only comprehensive but also reliable, thus increasing accountability and reinforcing stakeholder trust (Benameur et al., 2024; Simoni et al., 2019; Sphera, 2024).

## 2.3 Assurance in ESG reporting

As ESG reporting gains importance, the demand for third-party assurance has significantly increased (Sonnerfeldt & Pontoppidan, 2020). While the CSRD introduces mandatory assurance requirements, organizations also face increasing pressure from stakeholders to enhance the reliability, transparency, and credibility of their ESG disclosures (Prakash, 2020; Simoni et al., 2019). Given the issues of data incompleteness, quality inconsistencies, and the absence of standardized metrics, assurance plays a critical role in increasing stakeholder confidence in ESG reporting (Ruohonen & Kullas, 2024; Stocker et al., 2020).

Traditionally, assurance providers focus on financial information. However, the expansion of corporate reporting to include non-financial aspects necessitates a shift in assurance practices (Sonnerfeldt & Pontoppidan, 2020). This is emphasized by the research of Perego & Kolk (2012) as well, they state that, because of the broadening of focus in reporting, the scope of traditional (financial) third-party assurance engagements to include non-financial aspects becomes more relevant. This shift reflects the broader demands of regulators and stakeholders, aligning with the growing societal importance of sustainability.

Third-party assurance refers to an independent evaluation of a company's processes, systems, and data, aimed at confirming the accuracy and integrity of reported information (Olivier Boiral et al., 2017; Yan et al., 2022). Within ESG reporting, assurance typically covers key topics such as greenhouse gas emissions, workforce diversity, and supply chain impacts. The CSRD currently requires limited assurance, but this will evolve into reasonable assurance by 2028. Reasonable assurance involves a higher level of scrutiny and is intended to provide around 95% confidence in the accuracy of the disclosed information (Benameur et al., 2024; Sphera, 2024).

Assurance is often provided in the form of an audit. Auditing involves reviewing internal controls, identifying risks and recommending improvements to enhance transparency and regulatory compliance (Al Karabsheh et al., 2024). While the core principles of auditing apply, ESG assurance differs substantially from financial audits. In contrast to the well-established and globally recognized standards in financial audits, ESG assurance often lacks such standardized frameworks, contributing to inconsistent methodologies and limited comparability across firms (Sonnerfeldt & Pontoppidan, 2020).

Recent empirical studies highlight both the benefits and challenges of ESG assurance. For example assurance over ESG disclosures has been shown to positively influence stakeholder trust and promote accountability (Amran et al., 2024; Fung et al., 2024). However, gaps in practice remain. Ruohonen and Kullas point out the discretionary nature of ESG assurance, noting inconsistencies in scope and methodology between engagements (Ruohonen & Kullas, 2024). Similarly, Doxey and Sealy (2024)

observe that although more than half of ESG disclosures are assured, the majority fall under limited assurance and often include broadly defined scope limitations.

In addition, Krasodomska et al. (2025) demonstrate that companies actively engaging in trust-building through sustainability performance are more likely to obtain external assurance for their sustainability reports and strive for higher assurance quality. Furthermore, their findings suggest that a strong commitment to sustainability and reputation management motivates firms to adopt more comprehensive and in-depth assurance practices, thereby further strengthening the reliability of ESG-related information.

These findings indicate that while assurance over ESG information is expanding, the field is still maturing. Current practices show a lack of harmonization, both in the degree of assurance provided and, in the frameworks used. Scholars such as Hay (2024), Bauernhofer et al. (2024), and Benameur et al. (2024) emphasize the need for further research into assurance mechanisms, particularly focusing on internal control systems and standardized methodologies. This reflects an urgent call within the academic literature to better define the role and structure of ESG assurance within corporate reporting practices.

## 2.4 Information Technology in ESG reporting

With the introduction of the CSRD and the growing complexity of ESG disclosures, the demand for sustainability-related data has increased significantly. Recent literature highlights the pivotal role that information technology (IT) is expected to play in managing the large volume, variety, and complexity of ESG-data (Hummel & Bauernhofer, 2024). As business processes become increasingly digitized, organizations are progressively adopting IT systems not only to optimize operations but also to support strategic decision-making and reporting requirements (Aprilinda et al., 2019; Berghuis et al., 2024). These developments are now extending in the domain of ESG reporting.

The adoption of IT in the context of sustainability reporting is largely motivated by the need to handle complex data structures, improve data integration and enhance overall reporting accuracy (Heijnsbergen, 2024). Nevertheless, scholars note a limited understanding of how these technologies are effectively implemented. For instance, Svensson (2023) calls for further research into digital capabilities and how they can support sustainability-related data under the CSRD. Similarly, Pizzi et al. (2023) stress the need to explore the use of digital tools in ESG disclosures, focusing on their potential to improve efficiency and standardization, while also identifying risks such as inconsistent data quality and the long-term effects of digitalization.

Particularly relevant in this context are data-gathering technologies such as Enterprise Resource Planning (ERP) systems and Internet of Things (IoT) devices. These technologies enable organizations to automate, integrate, and monitor ESG-data in a scalable way (Darius Dudek, 2024). ERP systems

act as centralized platforms where ESG metrics could be tracked and aligned with financial and operational data, improving consistency across disclosures (Markova-Karpuzova et al., 2024). Hummel and Bauernhofer (2024) highlight the need for companies to further professionalize their ERP systems and emphasize that organizations should leverage their existing IT infrastructure, particularly ERP systems, to meet the increasing data requirements introduced by the CSRD (Hummel & Bauernhofer, 2024).

IoT devices, on the other hand, enable real time data collection on key environmental indicators such as energy consumption, emissions, and wase levels (Lauzzana, 2023). By automating the capture of these metrics, IoT can reduce the reliance on manual processes and improve data granularity. However, these systems may also introduce significant risks, including data privacy concerns, cybersecurity vulnerabilities, and challenges in integrating real-time data into formal reporting structures and assurance processes (Kirchhoff, 2024; Markova-Karpuzova et al., 2024). Despite the potential benefits, the application of IoT in ESG reporting remains underexplored in academic literature, indicating a need for further research to understand its implications fully.

While the potential of IT to improve the efficiency, reliability, and scope of ESG reporting is widely acknowledged, the literature also cautions against its uncritical adoption. The author Markova-Karpuzova et al. (2024) note that although tech-based ESG platforms offer promising capabilities, they are often accompanied by integration difficulties, quality concerns, and ethical issues such as algorithmic bias. Kirchhoff (2024) similarly warns of emerging threats, including the possibility of IT-enabled greenwashing and insufficient safeguards for data security. Lessons from financial reporting further underscore these risks, where the adoption of IT has been associated with data breaches, fraud, and system failures (Dzuranin & Mălăescu, 2016).

In summary, the integration of IT, more specifically ERP systems and IoT devices, in ESG reporting presents both opportunities and challenges. As ESG disclosures become more regulated and data-intensive under the CSRD, further research is required to understand how these technologies can be responsibly leveraged while mitigating associated risks. The academic literature in this area remains in its early stages, indicating a clear research gap and justifying the relevance of this study.

## 2.5 Information Technology auditing

The CSRD increases the reliance on information technologies for ESG reporting, particularly to manage complex data flows and ensure transparency. While these systems offer enhanced efficiency and accuracy, they also introduce new risks, such as cybersecurity threats, data integrity issues, and integration complexities. To address these risks, IT auditing emerges as a crucial function that supports the reliability of ESG reporting systems (Al Karabsheh et al., 2024).

Although traditional audits primarily focus on the accuracy of financial statements, modern audit practices increasingly depend on IT auditors due to the growing integration of IT systems into financial and ESG reporting processes (Dzuranin & Mălăescu, 2016; Rout, 2024).IT audits examine whether the systems that produce, process, and store data are reliable, secure, and aligned with regulatory expectations. This makes IT auditing a foundational element for ensuring assurance in financial reporting (Steinbart et al., 2018).

IT auditing consists of assessing the infrastructure, operations, and controls surrounding an organization's information systems. This includes both technical aspects (e.g., system security) and governance mechanisms (e.g., policy compliance). A key contribution of IT auditing lies in evaluating internal controls, identifying system vulnerabilities, and supporting risk mitigation strategies (ISACA, 2018; Tarek et al., 2017). These controls not only ensure operational integrity but also contribute to strategic decision-making by improving overall IT governance.

To carry out these responsibilities, IT auditors rely on standardized frameworks, such as COSO and COBIT 2019. These frameworks guide auditors in planning, risk assessment, control evaluation, testing, and reporting (Haes et al., 2019; Moeller, 2014). Figure 3 visualizes key IT audit activities based on these frameworks.
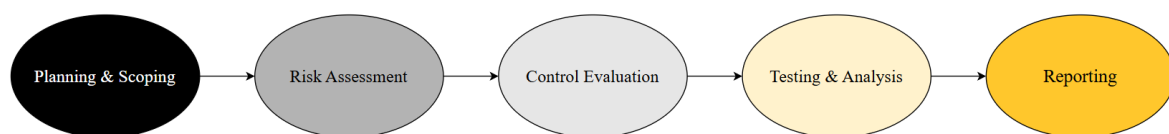


*Figure 3: Key activities of an IT auditor*

During the planning and scoping phase, auditors define the systems and controls to be reviewed. Risk assessment then identifies the most pressing IT-related risks—ranging from rapid system changes and personnel shifts to the implementation of new technologies (Singleton, 2007). These risks help prioritize which controls need the most scrutiny.

Control evaluation follows, focusing on the effectiveness of internal controls at two levels: application controls (e.g., invoice processing systems) and IT general controls (e.g., access management and system integrity). Robust general controls should ensure system reliability, data accuracy, secure program development, and business continuity (Moeller, 2014). Weaknesses in these areas can compromise ESG disclosures or even open organizations to regulatory sanctions.

Testing is the next step, where auditors use techniques such as log analysis, penetration testing, and data validation to assess whether controls function as intended. These methods verify whether processes such as data entry, report generation, or system updates occur without errors or manipulation

(ISACA, 2018). Testing also supports assurance over ESG-data systems by identifying potential failures in the data pipeline.

The final phase is reporting, where IT auditors communicate findings to management and the audit committee. Reports must be accessible to non-technical stakeholders and clearly outline identified risks, their implications, and recommended actions. This step is essential to drive accountability and remediation (Moeller, 2014).

As demonstrated, IT auditors play a critical role in ensuring the integrity, security, and reliability of an organization's information systems. Their work is guided by standardized frameworks and includes activities such as risk assessment, control evaluation, and testing, all essential to ensure data quality and system reliability. With the growing dependence on technologies like ERP and IoT in ESG reporting, these same IT audit practices are becoming increasingly relevant in the sustainability domain.

## 2.6 Information Technology auditing in ESG reporting

While IT auditing is widely established in the financial reporting domain, its application in the context of ESG reporting remains significantly underexplored. Existing academic literature offers limited guidance on how IT auditors can contribute to the assurance of ESG-data, particularly under the regulatory framework of the CSRD. This gap underscores the need for further research into how established IT audit methodologies can be adapted or extended to support the credibility and reliability of sustainability disclosures.

The CSRD introduces a regulatory obligation for organizations to disclose extensive ESG information based on standardized metrics and structured frameworks, such as the ESRS. These disclosures are expected to be reliable, complete, and auditable. However, the complex IT systems that enable ESG-data collection, such as ERP platforms, IoT devices, and ESG software tools, introduce new risks related to data accuracy, security, and integrity (Hummel & Bauernhofer, 2024; Kirchhoff, 2024). As it is expected that these systems form the technological backbone of sustainability reporting now, and even more in the near future, their reliability becomes a key condition for the overall trustworthiness of ESG disclosures.

Despite this, the role of IT auditors in evaluating and assuring these systems is scarcely addressed in the current literature. ESG assurance practices have so far focused largely on traditional (financial) audit functions or sustainability experts, while the technical risks and IT control mechanisms embedded in ESG-data flows remain under-audited and poorly understood (Benameur et al., 2024; Doxey & Sealy, 2024). This creates a gap between the increasing reliance on digital infrastructure and the assurance procedures applied to those infrastructures.

IT auditors are uniquely positioned to fill this gap, given their expertise in evaluating system reliability, access controls, data integrity mechanisms, and cybersecurity, all of which are essential for high-quality ESG reporting. As such, their involvement could enhance the reliability of ESG disclosures and strengthen stakeholder trust. However, there is limited empirical research on how IT auditors can apply their expertise to ESG reporting processes.

In summary, the literature suggests that while IT audit practices have matured in the financial domain, there is limited literature available on how these practices can support providing assurance on ESG-data that has to be reported under the CSRD. This underlines the urgency for research into current ESG reporting processes, the role of IT in this and the role of (IT-) auditors in this process. Exploring this intersection is crucial for ensuring that ESG reporting is not only compliant and transparent, but also technically robust and secure.

## Key insights from literature

Taken together, the literature overall highlights an evolving landscape in which ESG reporting is increasingly supported by advanced information technologies. However, this digitalization brings new risks and complexities that are not yet fully understood, especially in light of the CSRD's stricter requirements. While numerous studies emphasize the importance of data reliability and assurance, few have examined how the specific technologies that are needed, like ERP systems and IoT devices, affect the accuracy, completeness, and verifiability of ESG-data. Even less is known about how IT auditors might systematically contribute to the assurance of such data, despite their technical expertise being highly relevant. These gaps provide the foundation for this thesis, which aims to contribute new insights into how these technologies can be both a source of risk and opportunity, and how the audit profession must evolve in response.

## Conceptual Framework

This section covers the key concepts related to the main research and sub-questions. It will explain the conceptualization and dimensions of each concept. The key concepts in this research include, 1) *The current state of data gathering technologies in ESG reporting*, 2) *The main risks of data gathering technologies in ESG reporting*, 3) *The opportunities of data gathering technologies in ESG reporting* and 4) *The current and future assessment of data gathering technologies in ESG assurance*.

The first part relates to the degree of technological integration in the ESG reporting process. It includes the maturity of IT systems, the extent to which data gathering technologies are used (ERP modules, IoT sensors), and the reliance on other manual tools. The second part relates to the technological and organizational risks that emerge from both the use and absence of data gathering technologies. Literature highlights risks such as data privacy, system integration, and auditability. The third concept concerns the positive potential of technologies such as ERP and IoT in improving ESG-

data quality. These include benefits like process automation, data standardization, real-time monitoring, and enhanced internal control. Literature often presents these benefits in idealized form. The last part refers to how assurance providers, especially (IT) auditors, currently evaluate, and are expected to evaluate in the future, the reliability and control environment of ESG reporting systems.

To highlight the relationship between the variables, a conceptual framework has been established, see figure 4. The framework outlines how the current state of technology impacts both the risks and opportunities of data gathering technologies in ESG reporting, which in turn influences how these technologies are assessed for assurance purposes. This conceptual structure provides a guiding lens for analyzing and interpreting the findings presented in Chapter 4.
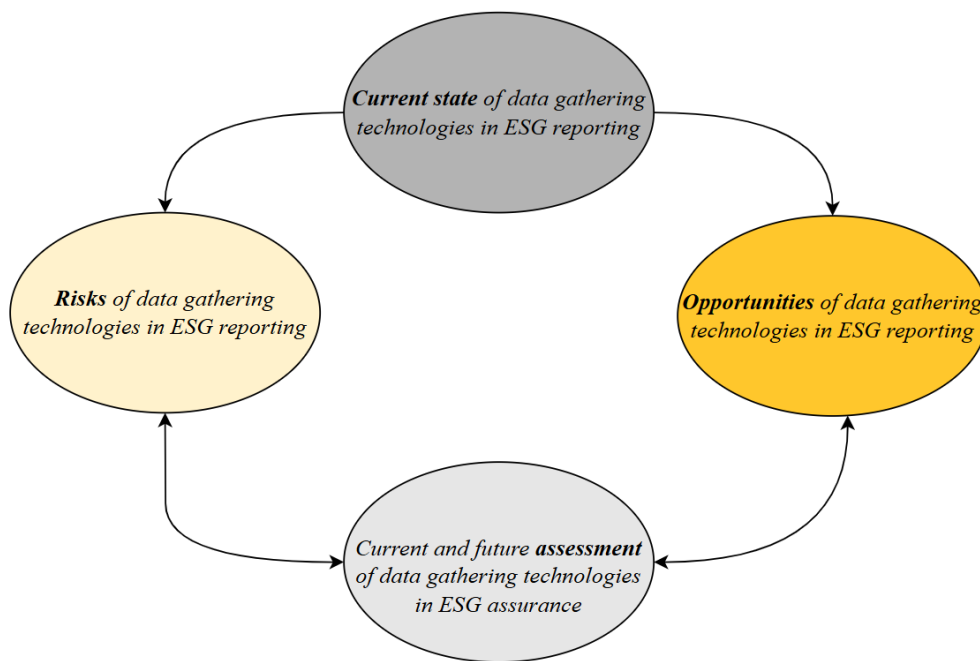


*Figure 4: Conceptual framework*

This conceptual framework has been developed to directly address the central research question: *What are the opportunities and risks of data gathering technologies, specifically ERP systems and IoT devices, in ensuring the accuracy, completeness, and reliability of ESG-data for compliance with the Corporate Sustainability Reporting Directive (CSRD)?*

It does so by studying the current state of data gathering technologies and both the risks and the opportunities it introduces associated with ESG reporting. These risks and opportunities are further shaped by how data gathering technologies are currently assessed in ESG assurance practices under the CSRD. As such, the framework provides a structured lens through which the role of ERP and IoT technologies in enhancing or undermining ESG-data reliability can be systematically analyzed, in line with the requirements and assurance expectations set by the CSRD.

# 3 Methodology

The methodology section contains research design and elaborates on the context of the study and conceptualization, the data collection, and the data analysis. In addition, the validity and reliability of the research have been addressed to ensure the credibility and replicability of the findings.

## 3.1 Research context

## 3.2 Research design

To answer the main research question, a qualitative research design was adopted, grounded in the context of EY Netherlands.

### 3.2.1 Data collection

As outlined in the research context, the study was conducted within the IT audit department of EY, a Big Four firm actively engaged in ESG-related engagements under the CSRD. Given the interdisciplinary nature of ESG assurance, a research approach has been designed that includes perspectives form several relevant respondents' groups. The structure of this approach is visualized in figure 5.

1. Climate Change and Sustainability Services (CCaSS) professionals
2. IT auditors
3. IT and ESG specialists
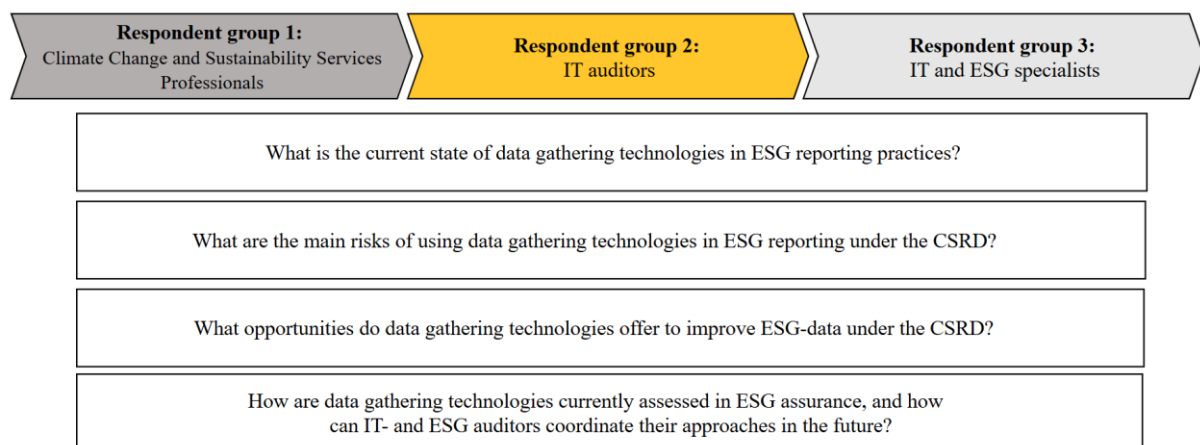


*Figure 5: Structure of the research design*

To ensure both depth and contextual relevance, semi-structured interviews form the core of the data collection method. Semi-structured interviews are well-suited for exploratory research as they combine the consistency of guided questioning with the flexibility to explore emerging themes in more detail (Adams, 2015).  The interviews were organized in phases to capture insights from professionals with hands-on experience in ESG reporting, assurance, and IT systems. This phased structure was

deliberately designed to reflect and integrate the diverse perspectives of specialists across these domains, enabling a comprehensive understanding of how data gathering technologies are applied and assessed in practice. This qualitative approach is appropriate given the aim of the study to explore perceptions, practices, and challenges in a relatively new and complex regulatory context. Qualitative research methods are particularly effective for examining context-dependent knowledge and gaining deep insights into how professionals interpret and respond to evolving requirements (Bazeley, 2008).

In the first set of interviews, five CCaSS professionals were interviewed, in one-on-one sessions of approximately one hour each. These interviews focused on how ESG disclosures are currently prepared, the perceived role of data gathering technologies in this process, and the challenges in meeting CSRD assurance requirements. Respondents were asked about relevant practical experiences in which data gathering technologies such as ERP or IoT are being used in the ESG reporting process. A selection of guiding questions used for the semi-structured interviews is included in the appendix.

Based on these interviews, a second group of five IT auditors was selected, specifically those working on overlapping client engagements. These interviews also lasted approximately one hour each. This made it possible to explore the same ESG reporting processes from an IT audit perspective. These interviews provided insights into how IT auditors currently view the reliability, auditability, and risks of data gathering technologies used in ESG reporting under the CSRD.

At last, five additional respondents were interviewed who hold roles that bridge both ESG and IT domains, with each interview lasting approximately one hour. These professionals offered a broader view on the current state of data gathering technologies in the context of the CSRD, how IT and sustainability teams can align in evaluating ESG systems, and where assurance responsibilities might be shared or divided.

By structuring the interviews to reflect the variety of roles involved in ESG reporting and assurance, this approach facilitates a deeper understanding on how data gathering technologies are currently used, evaluated, and coordinated across disciplines. It allows for the identification of practical challenges, complementary expertise, and potential disconnects between the fields of IT, ESG, and assurance. This layered setup strengthens the practical relevance of the findings by drawing on firsthand professional experiences and reflecting current organizational practices.

To ensure a comprehensive understanding, respondents have been selected based on varying levels of experience, roles, and involvement in ESG reporting. Conducting the study within EY enabled the use of an existing professional network, which served as the foundation for selecting participants across different ranks, from senior staff-level employees to directors and partners. To ensure the diversity of the respondent group more, not only colleagues from EY Netherlands have been interviewed but also colleagues based in other European countries and colleagues based in the United States. By having

included a diverse range of professionals, the study aimed to capture a wide variety of perspectives, making the findings applicable to a broad group of stakeholders involved in ESG compliance.

| Roles | Respondent group 1: Climate Change and Sustainability Specialists | Respondent group 2: IT auditors | Respondent group 3: IT and ESG specialists |
|---|---|---|---|
| Partner | 1 | | 1 |
| Director | | 1 | |
| Senior Manager | 2 | 1 | 3 |
| Manager | | 1 | 1 |
| Senior Staff | 2 | 2 | |
| Duration | ± 5 hours | ± 5 hours | ± 5 hours |

*Figure 6: Overview of the variety in respondents*

### 3.2.2 Data analysis

The semi-structured interviews were systematically coded and analyzed using the Gioia methodology, a qualitative research approach developed to structure and interpret complex phenomena based on participants' experiences (Gioia et al., 2013). This method is particularly well-suited to exploratory research, as it allows for the identification of emerging patterns, relationships, and conceptual categories grounded in the data. By applying the Gioia method, this study developed a structured representation of how professionals in ESG assurance and IT audit perceive and interact with data gathering technologies in the context of ESG reporting. This analytical approach supports the development of empirically grounded insights that contribute to a deeper understanding of the evolving role of IT in ESG reporting under the CSRD.

### 3.3.3 Reliability and validity

To ensure the credibility of the study, attention has been paid to both reliability and validity. The research design leverages semi-structured interviews conducted in distinct phases with respondents from different functional backgrounds. This setup provided complementary perspectives and allowed for a systematic exploration of the role of data gathering technologies, particularly ERP systems and IoT devices, in ESG reporting and assurance under the CSRD.

The semi-structured format offers flexibility to capture individual experiences while maintaining consistency across interviews. This approach supports internal validity by uncovering emerging themes and allowing respondents to elaborate on challenges and practices in context (Adams, 2015). Interviewing three respondent groups, see figure 6, ensures that insights reflect a broad spectrum of expertise, reducing the risk of bias and increasing construct validity (Tobin, 2018).

Triangulation further reinforces validity. The combination of perspectives from multiple roles, geographical contexts (e.g., respondents from EY Netherlands, other European countries, and the

United States), and the integration of insights from academic literature and CSRD guidance, ensures that findings are well-rounded and grounded in both theory and practice (Middleton, 2025).

Reliability is addressed through the transparent documentation of the research process (Lorelli Nowell, 2017). Interview procedures, sampling criteria, and the coding approach are clearly recorded to support replication. Additionally, academic literature has been sourced from recognized databases such as Google Scholar and Scopus. To enhance transparency and ensure reproducibility, the interview guide used for the semi-structured interviews and the coding scheme have been included in the appendix to enhance transparency and support reproducibility.

# 4  Results

Within this chapter, the findings of the research will be presented to answer the main research question and sub-questions. The chapter is based on the collected perspectives gathered during the semi-structured interviews and aims to show how individual perspectives evolved into a broader shared understanding. This forms the basis for answering the central research question: ***What are the opportunities and risks of data gathering technologies, specifically ERP systems and IoT devices, in ensuring the accuracy, completeness, and reliability of ESG-data for compliance with the Corporate Sustainability Reporting Directive (CSRD)?***

The chapter will begin with an exploration of how data gathering technologies, particularly ERP systems and IoT devices, are currently being used within ESG reporting practices. This provides the necessary context to understand how organizations are already engaging with these technologies in light of the emerging requirements under the CSRD. Following this, the analysis turns to the key risks associated with these systems, including concerns around data reliability, integration challenges, and security vulnerabilities. These insights are crucial for understanding the potential pitfalls that may hinder effective ESG reporting.

Building on this, the chapter highlights the perceived opportunities offered by data gathering technologies to improve the quality, traceability, and efficiency of ESG-data collection and reporting processes. At last, attention shifts to the assurance dimension, examining how these technologies are currently evaluated within ESG audits and how IT auditors and ESG specialists might better coordinate their efforts in the future.

## 4.1 Current integration of data gathering technologies in ESG reporting

This section addresses the first sub-question: ***What is the current state of data gathering technologies in ESG reporting practices?***

Based on the analysis of the semi-structured interviews, it was found that ESG-data gathering technologies remain immature and fragmented. Organizations face significant challenges in integrating systems for ESG reporting, leading to inconsistent data gathering practices and heavy reliance on manual tools as Excel. Table 1 presents the data structure developed through the Gioia methodology, the full coding scheme, including first order concepts can be found in appendix 2.

| Second-order themes | Aggregate dimension |
|---|---|
| Immature and fragmented ESG Tooling | Limited digital integration in ESG-data gathering |
| Diverse technology approaches across organizations | |
| Slow adoption of automation and direct measurement | |

*Table 1: Coding scheme Current integration of data gathering technologies in ESG reporting*

The findings are structured into three key themes: **Immature and fragmented ESG Tooling**, **Diverse technology approaches across organizations** and **Slow adoption of automation and direct measurement**. These themes form the basis of the aggregate dimension **Limited digital integration in ESG-data gathering**.

### 4.1.1 Immature and fragmented ESG tooling

A recurring theme across the interviews was the immature and fragmented state of tooling used for ESG-data gathering. Respondents emphasized the lack of integrated systems, resulting in a strong reliance on manual processes, which has consequences for the accuracy, completeness, and reliability of ESG-data.

Many respondents noted a strong reliance on Excel as the primary tool for ESG-data gathering. One respondent noted, *"Excel is the basis of ESG reporting"*, while another emphasized, *"Most companies use Excel and do not use more mature reporting systems, with the exception of exceptions."* These findings indicate that ESG reporting is still largely dependent on manual processes, despite increasing regulatory pressure.

The use of Excel introduces significant risks. As one respondent explained, *"Excel is just not going to cut it, quality-wise … it creates a lot of issues."*. Another respondent described the landscape as *"a bunch of disconnected boxes"*, highlighting the lack of a unified approach. Additionally, a participant shared, *"often it is all information that is manually entered into different Excel sheets"*, underlining the inefficiency and potential for error.

Moreover, a lack of clear ownership over ESG-related data was seen as a major barrier in the current state of the usage of data gathering technologies in ESG reporting. One respondent remarked, *"finding the person who is responsible for the data that is coming into the systems, applications, or processes, and the controls within the application, is much harder then in financial reporting"*. This fragmentation complicates internal control implementation and makes external validation more difficult.

In sum, current ESG tooling is often immature and fragmented, highlighting the limited digital integration of data gathering technologies in ESG reporting.

### 4.1.2 Diverse technology approaches across organizations

The interviews revealed a considerable variation in how organizations adopt technology for ESG reporting. Respondents noted that currently there is no universal solution, and that technology adoption in ESG reporting often depends on an organization's internal IT maturity.

Several respondents observed that organizations are currently adopting a mix of off-the-shelf solutions, customized in-house developments, and hybrid systems. One respondent noted, *"What we*

*see is that companies have own build systems, or they buy an off-the-shelf solution, and they customize it"*, another added, *"Large software developers who offer large financial ERP packages are also in the process of developing ESG modules."*.

Furthermore, the overall level of IT maturity within an organization plays a significant role in adopting data gathering technologies in the ESG reporting process. *"It all depends on how large, internationally active, and mature an organization is."* one respondent explained. Another added *"Some companies are pretty far with collecting ESG information. Others are just still trying to figure it out."*. Another respondent underlined, *"It is hard to sketch a complete overview of IT being used in ESG reporting because it really differs a lot."*.

Thus, the diversity of approaches across organizations indicates that the technology landscape in ESG reporting is still in development, lacking maturity and standardization.

### 4.1.3 Slow adoption of automation and direct measurement

A third theme that emerged was the slow adoption of automation and direct measurement technologies. Manual processes and the use of proxies are still widespread, limiting reliability and real-time insight.

Manual data entry remains the norm in ESG-data gathering. *"It actually all comes from Excel."* one respondent noted. Excel is extremely error-prone, especially if people have to manually fill in things."*, another added, *"It is often all information that is manually entered into Excel sheets."*.

There is also heavy reliance on proxy data. One participant mentioned, *"Just like other datapoints, scope 3 emissions are done via calculations with proxies in Excel and an estimate is being made"*. Another added, *"We pay the energy supplier and see on the bill what we used, then attach an emission proxy."*.

The use of IoT and sensor-based systems remains limited in ESG reporting. *"The actual measurement is done very little at my customers, most of the calculations are made using proxies"* one stated. *"I see that many more estimates are used than actual sensor-based measurements,"* another added. However, there are exceptions. Large industrial firms, particularly in oil, gas, and chemicals, are more advanced. One respondent stated, *"Dirty companies, like oil and gas, and chemistry, have been doing this for a long time. They use this data operationally, but it can also be used for external reporting."*. Another added, *"Much of the data for dirty clients was already being captured through existing EHSS (Environmental, Health, Safety, and Sustainability) systems before the CSRD requirements came into force."*

Overall, the limited use of automation and direct measurement illustrates that the technological landscape for ESG-data is still developing, with many organizations yet to reach sufficient maturity for reliable and standardized data reporting.

### 4.1.4 Theoretical reflection on the current state of data gathering technologies in ESG reporting

The literature review emphasized the growing use of ERP systems and IoT devices in ESG reporting (Baumuller & Grbenic, 2021; Darius Dudek, 2024). ERP platforms are highlighted for structuring and integrating data, while IoT technologies are expected to enhance real-time monitoring (Lauzzana, 2023). Yet, research also acknowledges the early stage of digitalization in ESG reporting (Pizzi et al., 2023; Svensson, 2023).

The empirical findings confirm that digitalization is still immature. While some ERP systems are being enriched with ESG modules, most companies still rely heavily on Excel. IoT applications are mostly limited to large, emission-intensive firms. Technological adoption varies significantly depending on company size, IT maturity, and resources. In line with theory, ERP systems show potential but are underutilized. IoT's potential still remains largely theoretical for now. Contrary to some academic optimism, digital integration for ESG remains uneven and slow in practice. There is a widening gap between CSRD requirements and actual technological capabilities across organizations.

## 4.2 Risks of data gathering technologies in ESG reporting

This section addresses the second sub-question: ***What are the main risks of using data gathering technologies in ESG reporting under the CSRD?***

Building on the findings in the previous section, which demonstrated that ESG-data gathering technologies are still in an immature and fragmented state, this section takes a more nuanced perspective. While the initial research objective focused on identifying general risks posed by data gathering technologies in ESG reporting, the empirical data shifts this emphasis. It reveals that the current state of technological immaturity itself gives rise to a variety of practical and structural risks. Rather than hypothetical risks of future technologies, these findings reflect the challenges organizations currently face due to their reliance on underdeveloped tools, manual processes, and unclear responsibilities. The focus in this section is therefore on the real-world consequences of today's ESG reporting landscape, in the light of assurance requirements under the CSRD.

Based on the findings of the research, two aggregate dimensions emerged: **Limited maturity of data gathering technologies in ESG reporting creates risks** and **Complexity of ESG-data and the IT landscape**. These dimensions reflect how technical shortcomings and fragmented data environments hinder the reliability, traceability, and auditability of ESG-data. Table 2 presents the data structure developed through the Gioia methodology, the full coding scheme, including first order concepts can be found in appendix 2.

| Second-order themes | Aggregate dimension |
| --- | --- |
| Weak control over manual data changes | Limited maturity of data gathering technologies in ESG reporting creates risks |
| Inadequate access and authorization procedures | |
| Immature ESG-specific tooling and integration | |
| | |
| Data flow complexity complicates assurance & Challenges in ESG-data mapping | Complexity of ESG-data and the IT landscape |

*Table 2: Risks of data gathering technologies in ESG reporting*

The findings are divided into four key themes: **Weak control over manual data changes**, **Inadequate access and authorization procedures**, **Immature ESG-specific tooling and integration** and **Data flow complexity complicates assurance & Challenges in ESG-data mapping**. Out of these themes, the aggregate dimensions were derived.

## 4.2.1 Weak control over manual data changes

A commonly cited risk mentioned involves undetectable manual modifications to data due to a lack of automated control mechanisms. ESG-data is often handled manually, in Excel, bypassing validations and approvals. As one respondent described, *"Excel is extremely error-prone, especially if people have to manually fill in things, transfer, make calculations, then a mistake is of course easily made."* Another respondent described using Excel in ESG reporting as *"a total nightmare. There are no controls or quality checks behind it. You have no idea if it was entered correctly, who did it, when somebody did it, whether it has been approved or checked by someone else.".*

In many organizations, ESG-data flows through disconnected systems and is manually consolidated. *"We also have to focus on consolidated data that comes out many different systems, therefore we have to assess whether no data has been lost, no changes have been made etc. in the consolidation process"*, one respondent noted. This limited visibility introduces substantial risks to both accuracy and auditability.

Because of the immature state, preventive controls, like automated approval flows or enforced segregation of duties, are often absent. This makes it difficult to trace ESG-data origins, verify correctness, and ensure completeness. Weak control environments ultimately undermine ESG reporting reliability under the CSRD.

## 4.2.2 Inadequate access and authorization procedures

Respondents highlighted insufficient enforcement of access controls and unclear authorization structures. One respondent mentioned *"When you look at the responsibility, finding the person who is responsible for the data that is coming into the system, the application, and the controls within the application, is much harder. [...] And looking from an access point of view, these systems probably*

*have not been looked at and have probably never been assessed.".* Another added, "Finding the person who is responsible for the data, the application, and the controls is much harder then in financial reporting because of the immature landscape".

Furthermore, unregulated access, particularly in smaller or less mature firms, also introduces operational risk. *"People running these systems in a company mostly consist of one person, and when that person leaves it can be quite dangerous.".*

Without clearly defining responsibilities and access restrictions, control principles such as four-eyes or user-level separation are inconsistently being applied. This complicates validation and increases the risk of unauthorized changes, further weakening ESG reporting credibility.

### 4.2.3 Immature ESG specific tooling and integration

The empirical findings show that ESG reporting still depends on fragmented and underdeveloped IT tooling. Many systems that are used were not built for ESG purposes. As one respondent stated," We *are still in a phase of lots of different products, and lots of different vendors that fit multiple pieces. Because tracking ESG-data has never been a driver, there are no dedicated tools that are commonly being used".*

While ERP providers are beginning to introduce ESG modules, the coverage and integration of these solutions are far from being as advanced as in financial reporting. *"You see that large software developers are now offering ESG modules. [...] But it's still not something companies want to invest in heavily.".* Others mentioned the limited availability of comprehensive tooling altogether, with one respondent stating, *"There are also few large ERP providers that invest in such a comprehensive tool for sustainability reporting. Because there are many discussions about what is needed, and what the future will bring, there is also simply little to earn from it.".*

This lack of mature ESG reporting tooling leads to reliance on manual processes and workarounds, harming consistency, and traceability. Without solid IT foundations, internal governance is also being compromised, *"If you really look at the specific IT systems for sustainability, if they are even there, the internal governance is quite limited.".*

### 4.2.4 Data flow complexity complicates assurance & provides challenges in ESG-data mapping

The fragmentation and complexity of ESG-data flows pose significant assurance challenges. ESG-data typically originates from diverse systems across operations, HR, and third parties. *"We then discovered that you have to look at the whole ecosystem. Where is the data coming in? What are the interfaces? Etc."* one respondent noted.

Manually handled integrations further obscure data lineage. Data is often entered into Excel without traceability. *"There are no controls or quality checks behind it. You have no idea what the source of the data is, if it was entered correctly, who did it, when, or whether it was approved."* one respondent noted.

The lack of unified architecture, combined with evolving reporting requirements, results in inconsistent and non-scalable systems. *"The current systems used for data gathering, and the reporting structures are not yet truly designed for consistency or scalability needed in the future."* one respondent explained.

In summary, fragmented flows, manual consolidation, and unclear mappings limit the auditability and reliability of ESG-data needed to report under the CSRD.

## 4.2.5 Theoretical reflection on the main risks of the role of data gathering technologies in ESG reporting

Recent studies limitedly highlight the risks of using IT in ESG reporting, such as data privacy issues, manipulation risks, weak controls environments, and difficulties in ensuring auditability across fragmented systems (Dzuranin & Mălăescu, 2016; Kirchhoff, 2024; Markova-Karpuzova et al., 2024; Perego & Kolk, 2012). System fragmentation and poor governance structures are also cited as barriers to reliable ESG disclosures, as they hinder the ability to track, validate, and data from source to report (Pizzi et al., 2023; Svensson, 2023). Furthermore, several authors point the risk of greenwashing if organizations fail to implement robust control frameworks around ESG-data integrity (Kirchhoff, 2024).

The findings support this but shift the focus. Instead of speculative risks of advanced technologies, the real danger lies in today's immature setups. Manual processes, limited integration of data gathering technologies, and unclear responsibilities dominating, and undermining both reliability and assurance.

## 4.3 Opportunities of data gathering technologies in ESG reporting

In this section the third sub-question is being addressed: ***What opportunities do data gathering technologies offer to improve ESG-data under the CSRD?***

Building on the risks identified in the previous section, this part of the study shifts focus toward potential improvements. Interviews revealed that, despite the challenges and immaturity of current systems, there are promising opportunities to enhance ESG reporting through the implementation of technologies like ERP systems and IoT devices. Table 3 presents the data structure developed through the Gioia methodology, the full coding scheme, including first order concepts can be found in appendix 2.

| Second-order themes | Aggregate dimension |
|---|---|
| Improved accuracy and standardization through data gathering technologies | Improving ESG-Data Quality for Assurance through Data Gathering Technologies |
| Increased efficiency and control through data gathering technologies | |
| Establishing structured governance for aligned and rigorous ESG assurance | |

*Table 3: Opportunities of data gathering technologies in ESG reporting*

The findings are presented through different themes, **Improved accuracy and standardization through data gathering technologies**, **Increased efficiency and control through data gathering technologies** and **Establishing structured governance for aligned and rigorous ESG assurance**. The findings lay the foundation for the overall aggregate dimension **Improving ESG-data quality for assurance through data gathering technologies**.

## 4.3.1 Improved accuracy and standardization through data gathering technologies

Respondents identified ERP systems with ESG modules as key enablers for improving the accuracy and consistency of ESG reporting. Capturing and consolidating ESG-data into centralized systems such as ERP platforms, data hubs, or data lakes can reduce risks by providing a single source of truth. One respondent noted, *"There are certain ERP packages that can be enriched with ESG-data, and that is then used. The advantage of this is that it entails far fewer risks because these traditional ERP packages are already assessed during the financial audit and are more mature"*.

Standardization also plays a crucial role. Predefined templates and reporting structures offered by software vendors align with EU requirements and reduce interpretation errors. *"We see that some software providers already offer preformatted reporting structures based on EU regulations"*, one respondent explained. These tools have the potential to increase comparability and decrease reporting ambiguity.

Additionally, data gathering technologies like ERP-systems and IoT devices were frequently mentioned as a solution to reduce manual effort and errors. Respondents emphasized that automating processes with IT-supported controls not only improves data quality but also saves time. *"If you can plan out the reporting processes and support them with IT controls, which is not only improving the quality but is also going to cut down the amount of time."*.

## 4.3.2 Increased efficiency and control through data gathering technologies

Efficiency gains through technology were widely acknowledged by respondents. Furthermore, real-time monitoring was highlighted as essential for proactive sustainability management. Furthermore

excel-based processes are seen as too slow and error-prone for this level of responsiveness. *"You have to have an insight in ESG-data more than once a year, of you want to make a real difference and steer on the numbers. This can not be done via Excel or is far too time consuming."*, one respondent explained.

Automation of data flows was seen as another major benefit. Respondents noted that digital systems streamline ESG reporting cycles, reduce manual work, and improve scalability. *"When you report only with manual systems [...] it is going to be 2.5 times the effort that it would take in with a more digitalized approach."* one explained.

Digitalization also enhances control environments. IT-supported processes make controls more robust and auditable. As one respondent put it, *"If there are few controls, the accountant will become busier because we cannot rely on IT controls."*, implying that the absence of data gathering technologies, or system-based mechanisms, shifts the burden to manual checks. These insights underline the importance of embedding technology not only for efficiency but also for assurance purposes.

### 4.3.3 Establishing structured governance for aligned and rigorous ESG assurance through data gathering technologies

The results highlight that there is a growing need for structured governance frameworks to support the reliability of ESG-data and enable more robust assurance practices. In most interviews, the current limitations of limited assurance were pointed out, which often results in less formalized and lighter audit procedures. One respondent, for example, explained, *"So we do something with IT, but the work we do is much lighter, due to limited assurance"* while another respondent added, *"We do not look at this for limited assurance."*. What was found is that the lighter, limited assurance, requirement in ESG reporting reduces the scope of which (IT-) systems in the ESG reporting process have to be assessed. Which eventually makes ESG-data less traceable and also less reliable compared to financial data and financial reporting.

Beyond the assurance level, respondents highlighted the lack of clear ESG-specific control frameworks and ownership. One respondent noted, *"There are no specific real controls in it"*, and others mentioned that the responsibilities for these data and system controls are often unclear. *"When you look at the responsibility, finding the person who is responsible for the data, the system, and the controls is much harder."*. This absence of control maturity reflects the still-developing nature of ESG governance in many organizations. Another respondent putted it the as follows, *"Sustainability is not something that is equally applied or equally reported on by all companies. [...] It often never has been a driver."*.

Importantly, multiple respondents expect that this situation will be evolving as ESG assurance requirements were expected to become more stringent. What was found is that the upcoming shift

from limited to reasonable assurance could be seen as a turning point, *"If we were ever to move towards reasonable assurance, you would also have to take the step towards assessing IT."* one respondent noted. But later on, during the interview period, the omnibus proposal came in and many respondents referred to this regulatory push: *"The omnibus proposal states that reasonable assurance will be required for sustainability reports [...] This has a major impact on the possible role of IT and an IT auditor in ESG reporting."*.

In summary, at first, these findings indicate that establishing structured governance, including more clearly defined roles, control frameworks and more active IT involvement, is essential for aligning ESG reporting with future assurance standards. But the upcoming omnibus proposal, which narrows down the scope of companies subject to the CSRD and maintains limited assurance as the prevailing requirement (EuropeanCommission, 2025), may slow down this development. As a result, the earlier expected expansion of the role of IT systems and IT auditors in ESG reporting may not develop as quickly as initially expected. This creates uncertainty around the timeline and extent of the future role of IT and IT auditing in ESG reporting.

## 4.3.4 Theoretical reflection on the opportunities of data gathering technologies in ESG reporting under the CSRD

Theoretical literature suggests that ERP systems and IoT technologies can improve ESG-data quality by reducing manual errors, enabling real-time monitoring, and increasing process efficiency (Heijnsbergen, 2024; Markova-Karpuzova et al., 2024; Pizzi et al., 2023). Automated data flows and centralized systems can be seen as key enablers of reliable and auditable reporting.

The empirical findings largely confirm these views. Respondents acknowledged the benefits of automation, standardization, and integration, especially when implemented in mature IT environments. ERP systems with ESG modules were linked to improved reliability, while automation helped reduce reporting workloads and human error. However, the practical application of IoT technologies remains limited. Real-time environmental data collection is still rare, and many organizations continue to use proxy data and Excel-based systems. As a result, the full potential of digital technologies to enhance ESG reporting remains underrealized, and therefore, underexplored.

While both theory and practice recognize the transformative role that data gathering technologies can play, what was found is that recent regulatory developments, particularly the omnibus proposal, may slow down their broader adoption. As the shift to reasonable assurance has been postponed, companies may delay investments in more sophisticated ESG systems and controls. This indicates that the maturity of ESG-data practices is not only shaped by technological capabilities but also significantly influenced by regulatory pressure and clarity on assurance requirements.

## 4.4 Exploring how data gathering technologies are currently assessed in ESG assurance, and how IT- and ESG auditors can coordinate their approaches in the future

This section addresses the last sub-question: ***How are data gathering technologies currently assessed in ESG assurance, and how can IT- and ESG auditors coordinate their approaches in the future?***

The goal of this part of the study was to understand how IT auditors and ESG assurance providers currently assess data gathering technologies in ESG reporting, and how they can improve collaboration in the future to improve ESG reporting. Table 4 presents the data structure developed through the Gioia methodology, the full coding scheme, including first order concepts can be found in appendix 2.

| Second-order themes | Aggregate dimension |
|---|---|
| Limited assurance scope restricts technical validation | Limited maturity of IT assurance in ESG context |
| Lack of structured IT evaluation frameworks in ESG context | |
| Process-focused audits in ESG reporting with limited IT system assessment | |
| | |
| Regulatory uncertainty impacts collaboration needs | Aligning IT Audit and ESG Assurance Practices for Technology Evaluation in an ESG context |
| Absence of reasonable assurance limits IT audit involvement | |
| Limited focus on application controls in ESG practice | |
| Process-oriented collaboration remains key | |

*Table 4: Coding scheme Exploring how data gathering technologies are currently assessed in ESG assurance, and how IT- and ESG auditors can coordinate their approaches in the future*

This section builds on two aggregate dimensions identified during the coding process: **Limited maturity of IT assurance in ESG context** and **Aligning IT Audit and ESG Assurance Practices for Technology Evaluation in an ESG context**. These dimensions reflect the dual challenge of limited technical involvement in current ESG assurance and the emerging need for closer collaboration between IT and ESG professionals.

The first dimension highlights that ESG assurance engagements frequently fail to assess the reliability of ESG-related IT systems. Root causes include a narrow assurance scope, a lack of tailored evaluation frameworks, and an emphasis on process-level understanding over technical depth. The second dimension reveals that, while collaboration is recognized as important, regulatory ambiguity and unclear roles continue to hinder structured coordination between IT and ESG auditors.

## 4.4.1 Current limitations in IT assurance in the ESG context

Respondents emphasized that the current scope of ESG assurance engagements, which are mostly conducted under limited assurance, prevents meaningful technical validation of IT systems. Under this limited assurance regime, auditors are only required to obtain a general understanding of the reporting process rather than to test internal controls or evaluate system reliability. As one respondent put it, *"We do map out where all ESG-data comes from, but the link with the IT systems is often not analyzed. [...] We understand it, but we don't zoom in on the IT part."*. Another explained, *"We do not assess IT systems in the context of limited assurance, the testing of control measures is not part of the issuing of limited assurance activities."*.

This limitation is not incidental, but structural. ESG-related IT systems are often entirely excluded from audit scope because the assurance level simply does not require it. Respondents noted that limited assurance results in procedural, surface-level reviews, focusing on plausibility and completeness checks instead of deeper system testing. The result is a blind spot in the assurance process, which is especially critical as organizations rely more on digital infrastructure to generate ESG-data.

Additionally, several respondents highlighted that another reason IT auditing currently plays a limited role in ESG reporting is the immaturity of the ESG technology landscape itself, as described in chapter 4.1. While financial systems have long-established control frameworks and audit standards, many ESG-related systems are still in early stages of implementation. One respondent commented, *"If you really look at the specific IT systems for sustainability, if they are even there, the internal governance is quite limited."* The absence of robust, standardized ESG systems makes it difficult for IT auditors to apply traditional audit techniques effectively. As a result, many organizations lack the technological foundation necessary for meaningful IT assurance.

The absence of dedicated IT evaluation frameworks in the ESG domain was another frequently mentioned issue. Respondents indicated that existing approaches are mostly borrowed from financial audits. *"The audit work we do over the financial reporting can be more or less seen as the same in ESG reporting."* one interviewee explained. These borrowed methods can fall short in addressing the unique characteristics of ESG-data, its qualitative nature, its diverse sources, and the evolving regulatory standards.

Many ESG assurance assignments emphasize procedural understanding rather than actual validation of internal controls. *"There are no specific real controls in the IT being used and assessed itself."* said one respondent. As ESG-data often resides in fragmented systems managed by non-financial departments, technical reviews of system configurations, data lineage, and control mechanisms are rarely conducted. This limitation weakens both the robustness and the credibility of ESG assurance.

## 4.4.2 Challenges and opportunities for coordinating IT and ESG audit efforts

While most respondents recognized the need for better collaboration between IT and ESG professionals, they also pointed to several structural and regulatory barriers. A key theme was regulatory uncertainty, particularly surrounding the expected level of assurance under the CSRD. Many respondents pointed to the Omnibus Proposal as a turning point *"This proposal makes me doubt that reasonable assurance will have to be provided under the CSRD at all in the future."*.

Respondents noted that the Omnibus Proposal not only influences the assurance level but, because of this limited assurance level, also directly impacts how far organizations are willing to go in digitizing and professionalizing their ESG reporting processes. One respondent explained, *"We were looking into tools and automation, but since limited assurance stays, there is no real pressure to invest."*. Another added, *"This proposal has an enormous impact. If reasonable assurance was coming, it would change everything in the reporting process, then we would have to step up our game in terms of systems and IT involvement to be able to comply."*. A third respondent stated, *"Without stronger requirements, there is little incentive for organizations to mature the ESG reporting process."*.

Furthermore, because technical control testing, such as ITGCs or application control reviews, is typically reserved for reasonable assurance engagements, the use of limited assurance discourages organizations from involving IT auditors. *"The IT auditor will therefore be excluded to a very large extent."* one interviewee concluded.

In addition, what was found is that application-level control testing is still largely absent in ESG assurance assignments. *"Currently, data is often created through the knowledge and skills of sustainability officers. When it comes from systems, IT auditors can play a much more significant role,"* one respondent explained. However, without formal frameworks or requirements to involve IT, this expertise is often overlooked.

Despite these barriers, interviewees stressed the importance of collaboration across departments. ESG reporting relies on data from diverse systems, for example including HR, procurement, and third-party providers, which demands input from both ESG specialists and IT auditors. *"It is really important to work together with different departments with people with different knowledge."* one respondent emphasized. Another summarized this integration need by stating, *"The process around ESG reporting is input, throughput, output, we as IT auditors should check what goes in, how it flows, and what comes out."*.

In short, while both awareness and willingness to collaborate exists, actual coordination is limited by regulatory ambiguity, unclear role definitions, and a lack of formal structures. As ESG reporting becomes increasingly reliant on digital infrastructures, resolving these issues will be critical for delivering high-quality, verifiable ESG disclosures.

### 4.4.3 Theoretical reflection on the current and future assessment of data gathering technologies in ESG assurance under the CSRD

Theoretical literature emphasizes the importance of IT auditors in ensuring data integrity through validation of system reliability, general controls, and application-level controls (Al Karabsheh et al., 2024; Ruohonen & Kullas, 2024). Yet, empirical findings show that ESG assurance currently lacks this technical depth and collaboration.

From the outset of this research, it was observed that IT auditors hold expectations for a more prominent role in future ESG assurance, especially as digital data collection becomes more central. However, the findings of this study suggest that these expectations are not yet grounded in current practice. The combination of regulatory restraint, particularly the retention of limited assurance, and the limited maturity of ESG-related IT systems means that the anticipated IT audit role remains more aspirational rather than operational.

The findings of this study confirm that IT auditors are rarely formally involved in ESG audits, and if they are, their role is often limited to advisory input. Instead of structured control testing, ESG assurance still leans heavily on high-level plausibility reviews and documentation walkthroughs. A key insight from this study is how regulatory signals shape assurance practice. The Omnibus Proposal, which maintains limited assurance as the norm, significantly weakens the incentive to embed IT involvement in ESG audits. Without a clear requirement for reasonable assurance or detailed IT validation, organizations are unlikely to invest in system audits or an improved control design.

Thus, while the literature emphasizes a future of integrated, risk-based, and technically grounded ESG assurance, current practice remains fragmented. Moreover, the ESG reporting process overall still lacks maturity and professionalization in many organizations, impacting the applicability of IT auditors in ESG assurance assignments. Closing this gap will require not only more robust frameworks and methodologies but also regulatory alignment, clearer role definitions, and cross-functional collaboration between ESG and IT assurance teams.

# 5. Discussion and Conclusion

This section of the report evaluates and analyses the results of the study, addressing its contributions, limitations, future research, and practical implications. Furthermore, it includes a conclusion that discusses the results of this study and their contributions.

## 5.1 Discussion

### 5.1.1 Theoretical contributions

This study contributes to the growing body of literature at the intersection of ESG reporting, data gathering technologies, and assurance practices. By bridging assumptions in theory and real-world insights, it advances understanding in several ways.

**Bridging the gap between technological potential and actual practice**

While academic literature emphasizes the potential of ERP systems and IoT technologies to enhance ESG reporting by automating data flows, reducing manual errors, and improving traceability (Heijnsbergen, 2024; Markova-Karpuzova et al., 2024; Pizzi et al., 2023), this study shows that the practical application of these technologies remains limited. ERP systems are increasingly being equipped with ESG modules and different tools are being put out on the market, yet many companies still heavily rely on Excel and fragmented tools. This confirms that the digital maturity of ESG-data infrastructures is still significantly lagging behind both regulatory expectations and organizational needs (Anuradha, 2024) underscoring the disconnect between what technology is capable of and how it is actually used in ESG reporting practice.

**Highlighting data risks rooted in immature ESG reporting environments**

Existing literature focuses on hypothetical risks introduced by advanced technologies in the context of ESG reporting, such as data privacy issues, cyber risks, or algorithmic bias for example (Pizzi et al., 2023; Svensson, 2023). However, the findings of this study shift attention toward the more immediate and systemic risks posed by immature ESG-data environments. These include manual data handling, fragmented systems, undocumented data flows, and unclear responsibilities, all of which compromise auditability and reliability. Therefore, this research contributes to a more grounded understanding of risk by emphasizing that the absence or poor implementation of data gathering technologies in ESG reporting can be just as damaging, or even more, as its misuse.

**Clarifying how regulatory design influences technological adoption**

This study further adds to emerging work on the role of regulation in shaping technological transformation in ESG reporting. While academic literature often assumes that firms will adopt data gathering technologies in their ESG reporting process based on strategic or operational benefits

(Baumuller & Grbenic, 2021; Heijnsbergen, 2024), the findings reveal that regulatory clarity, particularly around assurance requirements, plays a critical role in shaping organizational incentives. The Omnibus Proposal's confirmation of limited assurance under the CSRD has led to resistance to change, as many companies delay investment in IT controls or ESG tooling. Thus, this study demonstrates that regulatory design is not just a compliance issue but a determining factor in the pace and depth of professionalizing the ESG reporting process and improving the accuracy, completeness, and reliability of ESG-data.

**Challenging the assumed role of IT auditors in ESG assurance**

Literature highlights the potential of IT auditors to strengthen ESG assurance by validating system reliability, application-level controls, and data lineage (Al Karabsheh et al., 2024; Joanna Krasodomska, 2025; Ruohonen & Kullas, 2024; Verweij, 2025). Yet this study shows that their involvement remains limited in current ESG assurance practices. Most assurance procedures still rely on high-level plausibility reviews and documentation walkthroughs, with minimal formal collaboration between IT audit and ESG assurance specialists. This not only challenges theoretical assumptions of integrated assurance models but also contrasts with the expectations that professionals had themselves. Several professionals at EY, particularly those from IT audit backgrounds, expressed the view that IT auditors will play an increasingly important role in ESG assurance as digitalization progresses. However, this study acknowledged that this development is currently hindered by the continued reliance on limited assurance under the CSRD, which reduces the urgency for organizations to involve IT auditors or invest in more mature and auditable ESG systems. This illustrates a disconnect between the direction professionals expect ESG assurance to evolve toward, and the structural incentives currently in place, highlighting the need for clearer regulatory signals and practical frameworks to accelerate IT audit integration.

## 5.1.2 Practical implications

This study offers several practical insights for organizations, assurance providers, and policymakers involved in ESG reporting under the CSRD. These implications are grounded in the empirical findings and conclusions, particularly regarding the current limitations in data gathering technologies use, data governance, and assurance practices in ESG reporting.

For organizations, the findings underscore an urgent need to reduce reliance on manual processes and fragmented reporting environments. The continued use of Excel and proxy data to make estimations, as observed in many companies, increases risks of human errors, poor traceability and eventually greenwashing. In line with earlier studies (Darius Dudek, 2024; Heijnsbergen, 2024; Markova-Karpuzova et al., 2024), this research confirms that data gathering technologies, such as ERP-based sustainability modules or dedicated ESG platforms can enhance the accuracy, completeness and reliability of ESG-data.

For assurance providers in ESG reporting under the CSRD, the study highlights a critical gap between the growing technical complexity of the ESG-data gathering process and the limited scope of current assurance procedures. While the ESG assurance practices are evolving, they still tend to focus primarily on high-level plausibility assessments and documentation reviews, with limited formal involvement of IT auditors. This is understandable given the current limited assurance standard under the CSRD, but it can also be seen as a missed opportunity. To address the growing need for assurance over data integrity and system reliability, providers are encouraged to expand their methodologies to include structured collaboration with IT auditors. Such integration would better reflect the technical realities of ESG reporting and help build a more future-proof assurance approach.

At last, for policymakers, this research identifies the current reliance on limited assurance, as reaffirmed in the Omnibus Proposal (EuropeanCommission, 2025), as a structural barrier to professionalizing the ESG reporting process under the CSRD. Without stronger regulatory pressure or specific guidance on IT-related assurance practices, organizations have less incentives to invest in digitalizing and formalizing their ESG reporting process. Policymakers should therefore consider issuing more detailed expectations regarding IT controls in ESG reporting and work toward a phased transition to reasonable assurance to improve the accuracy, completeness, and reliability of ESG-data. Providing such regulatory clarity would not only encourage investments in auditable ESG reporting processes but also strengthen the long-term reliability and comparability of ESG disclosures across sectors.

### 5.1.3 Limitations & Recommendations future research

Despite the contributions of the study, it has several limitations that should be considered. First, the aim was to provide in-depth and conceptual insights. Therefore, a qualitative design and the Gioia methodology were chosen. As a result of this approach, the findings are context-specific and cannot be generalized across all industries or organizational settings (Gioia et al., 2013).

Additionally, the respondents consisted exclusively of professionals from one Big Four firm, primarily located in the Duch and broader European context. This means the perspectives captured may not fully reflect practices in other regions, under different regulatory regimes, or within other types of organizations. Future research could expand the scope by including participants from multiple assurance firms or other types of organizations. This would enable comparative analysis across different organizational settings, regulatory frameworks, and assurance practices.

Secondly, the findings of this study are time-bound. ESG reporting and assurance practices are rapidly evolving, and the regulatory landscape, particularly under the CSRD, is subject to ongoing revisions. Notably, the Omnibus Proposal (EuropeanCommission, 2025) was published during the data collection phase. This directly influenced how participants viewed the future of ESG assurance, particularly with the confirmation that reasonable assurance will not be required in the near term. While this timing

gives the study unique value, as it captures professional perspectives during a critical moment of regulatory transition, it also means that some insights may lose relevance or require re-evaluation as policy and technology continue to develop. Future research could revisit these questions in light of future regulatory updates to track how assurance practices and IT involvement evolve over time, especially if higher levels of assurance become mandatory.

Another limitation concerns the technological scope of the study. While it touches on broader ESG reporting practices, the analysis focused specifically on ERP systems and IoT devices as data gathering technologies. Other potentially impactful technologies, such as AI-based analytics or blockchain were not included and could be examined in future research to gain a more comprehensive understanding of the technological ecosystem supporting ESG reporting.

The study primarily focused on large organizations that are already actively preparing for CSRD compliance. This was an intentional choice, as such organizations are the first to be directly impacted by the CSRD and most likely to be experimenting with advanced ESG tooling and assurance strategies. However, this focus means that the challenges faced by smaller or less mature organizations remain underexplored. Future research could therefore examine how these organizations approach ESG-data management and assurance.

## 5.2 Conclusion

The goal of this study was to explore the opportunities that data gathering technologies offer in enhancing the accuracy, completeness, and reliability of ESG-data required for CSRD compliance. Additionally, this research aimed to identify the risks associated with these technologies in the ESG reporting process. Given the CSRD's assurance requirements, the study further aimed to examine how these technologies are evaluated in current ESG assurance practices and how assurance practices could evolve in the ESG domain. Therefore, the research seeks to answer the main research question: "***What are the opportunities and risks of data gathering technologies, specifically ERP systems and IoT devices, in ensuring the accuracy, completeness, and reliability of ESG-data for compliance with the Corporate Sustainability Reporting Directive (CSRD)?***"

The first sub-question explored the current state of data gathering technologies in ESG reporting. The results show that while ERP systems are increasingly equipped with ESG modules, the overall level of digitalization remains low. Most organizations continue to rely on manual processes in Excel and other fragmented systems, particularly outside of emission-intensive sectors. IoT applications are rare and mostly experimental in the context of ESG reporting. The maturity of ESG-data infrastructures varies widely, influenced by company size, IT resources, and regulatory exposure.

The second sub-question addressed the main risks associated with data gathering technologies in ESG reporting. Rather than risks tied to advanced data gathering technologies themselves, this study finds

that the most pressing vulnerabilities come from their absence or immature implementation. These include manual data handling, lack of integration between systems, unclear data ownership, and poor traceability of data sources. Together, these conditions weaken the traceability and verifiability of ESG disclosures, posing a risk to assurance and increasing the likelihood of greenwashing.

The third sub-question investigated the opportunities that data gathering technologies offer in ESG reporting. The empirical results support the theoretical promise of ERP and IoT systems to reduce human error, streamline data flows, and strengthen auditability. What was found is that, when properly implemented, ERP-based ESG modules can significantly enhance data reliability. However, this potential is still largely underutilized. Real-time monitoring via IoT remains rare, and many organizations fall back on using proxies and estimations to calculate their figures, leading to inconsistent practices.

The last sub-question focused on the assessment of these technologies within ESG assurance. Despite the theoretical frameworks and assumptions in practice, which envision a growing role for IT auditors in validating controls and data integrity, this study reveals that current ESG assurance practices remain shallow. Assurance is typically limited to plausibility checks and documentation reviews with little formal involvement of IT auditors. The continued reliance on limited assurance, reaffirmed by the Omnibus Proposal, further discourages investments in professionalizing the ESG reporting process, including its control frameworks.

Bringing these findings together, the study concludes that, while ERP systems and IoT devices offer meaningful opportunities to improve the accuracy, completeness, and reliability of ESG-data, their current adoption and integration remains limited. The risks introduced by fragmented systems, reliance on manual processes, and a lack of governance currently outweigh the realized benefits of technological solutions. Furthermore, the current assurance environment under the CSRD does not provide sufficient pressure or incentives for companies to invest in more mature ESG-data infrastructures or IT-based control mechanisms.

To move forward, regulators and assurance bodies must recognize that the successful adaptation of technology in ESG reporting depends not only on innovation within organizations, but equally on clear regulatory expectations and consistent enforcement. Without regulatory pressure and structured guidance, companies are less likely to prioritize the investments needed to professionalize ESG-data reporting systems and controls. Clearer guidance, including a gradual shift toward reasonable assurance, could accelerate investments in data gathering technologies and encourage more structured IT audit involvement in ESG reporting. Ultimately, these developments are essential to improving the accuracy, completeness, and reliability of ESG-data, thereby enabling organizations to meet the requirements set by the Corporate Sustainability Reporting Directive (CSRD).

From a theoretical perspective, this study addresses several gaps in existing literature. First, while prior research has emphasized the potential of ERP systems and IoT devices in ESG reporting, few studies have examined how these technologies are used in practice, particularly in the early phase of CSRD implementation. This study contributes to literature by offering empirical insights into the disconnect between the technological potential and operational reality, highlighting that adoption of IT in ESG reporting is still fragmented and maturity levels are low. Second, existing literature mainly focuses on speculative risks of advanced technologies, whereas this research shifts the discussion to structural risks caused by the lack of digital maturity and weak governance in ESG reporting. Third, although scholars and practitioners assume that IT auditors will naturally play a key role in ESG assurance, this study challenges that assumption by showing that IT audit involvement is still limited, even in large, CSRD-affected organizations. One contributing factor is the regulatory climate itself, the Omnibus Proposal's reaffirmation of limited assurance in ESG reporting reduces the urgency for organizations to invest in auditable ESG systems or involve IT auditors in a formal way. These findings suggest that future research should further explore under what organizational, regulatory, or technological conditions IT and IT auditors become structurally involved in in ESG reporting and assurance. Future studies could build on these insights by investigating how ESG reporting practices evolve in response to regulatory shifts and technological advancements, and how these developments shape the role of IT in ensuring the reliability of ESG-data.

# Bibliography

Adams, W. (2015). Conducting semi-structured interviews. In *Handbook of practical program evaluation*.

AFM, A. F. M. (2023). *CSRD: geen tijd te verliezen*.

Aggarwal, P., & Singh, A. K. (2019). CSR and sustainability reporting practices in India: an in-depth content analysis of top-listed companies. *Social Responsibility Journal 15*, 1033-1053. https://doi.org/https://doi-org.ezproxy2.utwente.nl/10.1108/SRJ-03-2018-0078

Al Karabsheh, Y. K. A., Abdul, K. T., Shaqra, K. A., & AlQudah, M. Z. (2024). QUANTIFYING THE EVOLUTION OF IT AUDIT AND CONTROL PRACTICES: A BIBLIOMETRIC APPROACH. *The EDP Audit, Control and Security Newsletter*. https://doi.org/https://doi.org/10.1080/07366981.2024.2379497

Amran, A., Abbasi, M. A., Foroughi, B., & Tanggamani, V. (2024). Sustainability Reporting, Corporate Reputation, and Firm Performance: Moderating Role of Third-Party Assurance. *Corporate Reputation Review*. https://doi.org/https://doi.org/10.1057/s41299-024-00185-3

Anuradha, R. (2024). The Role of Technology in ESG Reporting: A Look at Emerging Trends and Best Practices. https://doi.org/https://www.lsegissuerservices.com/spark-insights/7LtaWpTsvoocFpBrV9TToV/the-role-of-technology-in-esg-reporting-a-look-at-emerging-trends-and-best-practices?utm_source=chatgpt.com

Aprilinda, Puspa, A., & Affandy, F. (2019). The Use of ISO and COBIT for IT Governance Audit *Journal of Physics: Conference Series*. https://doi.org/10.1088/1742-6596/1381/1/012028

Armstrong, A. (2020). Ethics and ESG. *Australasian Accounting, Business and Finance Journal*, *14*, 6-17. https://doi.org/https://doi.org/10.14453/aabfj.v14i3.2

Bakarich, K. M., Baranek, D., & O'Brien, P. E. (2022). The Current State and Future Implications of Environmental, Social, and Governance Assurance. *Current Issues in Auditing*, *17*(1), 1-21. https://doi.org/10.2308/CIIA-2022-012

Baumuller, J., & Grbenic, S. (2021). MOVING FROM NON-FINANCIAL TO SUSTAINABILITY REPORTING: ANALYZING THE EU COMMISSION'S PROPOSAL FOR A CORPORATE SUSTAINABILITY REPORTING DIRECTIVE (CSRD) *Economics and Organization*, *18*, 369-381. https://doi.org/https://doi.org/10.22190/FUEO210817026B

Bazeley, P. (2008). Analysing qualitative data: More than 'Identifying themes'. *THE MALAYSIAN JOURNAL OF QUALITATIVE RESEARCH*, *2*.

Benameur, K. B., Mostafa, M. M., Hassanein, A., Shariff, M. Z., & Al-Shattarat, W. (2024). Sustainability reporting scholarly research: a bibliometric review and a future research agenda. *Management Review Quarterly 74*, 823-866.

Berghuis, L., Abhishta, A., van Heeswijk, W., & Tursunbayeva, A. (2024). Group Workshop as a "Human-Centered Approach" for Identification and Selection of Business Processes for Robotic Process Automation. In *Towards Digital and Sustainable Organisations*. Springer. https://doi.org/10.1007/978-3-031-52880-4_7

Carroll, A. B. (2008). A History of Corporate Social Responsibility: Concepts and Practices. *The Oxford Handbook of Corporate Social Responsibility*, 19-46.

Darius Dudek, E. K.-D. (2024). Modern technologies in ESG reporting - evidence from Polish enterprises *28th International Conference on Knowledge-Based and Intelligent Information & Engineering Systems (KES 2024)*

Dathe, T., Helmond, M., Dathe, R., & Dathe, I. (2024). ESG Reporting Rules. In *Implementing Environmental, Social and Governance (ESG) Principles for Sustainable Businesses*. Springer, Cham.

Doxey, M., & Sealy, C. (2024). Comparing Auditors' and Users' Materiality Judgments for ESG and Traditional Financial Disclosures: The Roles of Disclosure Form, Valence, and Assurance Level https://doi.org/http://dx.doi.org/10.2139/ssrn.4314209

Dragomir, V. D., Dumitru, M., Chersan, I. C., Gorgan, C., & Păunescu, M. (2024). Double Materiality Disclosure as an Emerging Practice: The Assessment Process, Impacts, Risks, and Opportunities. *Accounting in Europe*. https://doi.org/https://doi.org/10.1080/17449480.2024.2339264

Dzuranin, A. C., & Mălăescu, I. (2016). The Current State and Future Direction of IT Audit: Challenges and Opportunities

Ann C. Dzuranin; Irina Mălăescu. *Journal of Information Systems*, *30*, 7-20.

EFRAG. (2024). *EFRAG Sustainability Reporting*.

EFRAG, E. F. R. A. G. (2023). *Publication of the 3 EFRAG ESRS IG documents (EFRAG IG 1 to 3)*.

EU, E. P. a. t. C. o. t. E. U. (2003). DIRECTIVE 2003/51/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. *Official Journal of the European Union*.

EU, E. P. a. t. C. o. t. E. U. (2006). Directive 2006/46/EC of the European Parliament and of the Council *Official Journal of the European Union*.

EU, T. E. P. a. t. C. o. t. E. U. (2014). Directive 2014/95/EU of the European Parliament and of the Council *Official Journal of the European Union*.

DIRECTIVE (EU) 2022/2464 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 14 December 2022

amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive

2013/34/EU, as regards corporate sustainability reporting (2022).

EuropeanCommission. (2025). Omnibus.

EY. (2024a). https://www.ey.com/nl_nl/about-us

EY. (2024b). *How to prepare for the EU's new sustainability disclosure requirements*.

Feroz, A. K., Zo, H., & Chiarvuri, A. (2021). Digital Transformation and Environmental Sustainability: A

Review and Research Agenda *Sustainability 2021*, *13*. https://doi.org/https://doi.org/10.3390/su13031530

Fischer, T., Adolph, J., & Zipse, O. (2023). *Road to Net Zero*. Springer.

Franziska Schutze, B. S. (2025). Taxonomy Disclosure in the EU– A Useful Framework, Despite Current Challenges. *Econ Voice*, *1*. https://doi.org/https://doi.org/10.1515/ev-2025-0016

Freeman, E. (2015). *Strategic Management: A Stakeholder Approach*. Cambridge University Press. . https://doi.org/10.1017/CBO9781139192675

Friedman. (1970). A Friednezion Doctrine. *New York Times Magazine*. https://www.nytimes.com/1970/09/13/archives/a-friedman-doctrine-the-social-responsibility-of-business-is-to.html

Fung, C. Y., Su, S. I., & Chang, J. S. G. (2024). A Review of Sustainability Reporting and Stakeholder Engagement: The Future Research Agenda. *International Journal of Business and Technology Management*, *6*, 1-13. https://doi.org/http://myjms.mohe.gov.my/index.php/ijbtm

Gioia, D. A., Corley, K., & Hamilton, A. (2013). Seeking Qualitative Rigor in Inductive Research. *Organizational Reserearch Methods*, *16*, 15-31. https://doi.org/10.1177/1094428112452151

Gupta, M., & Sharman, R. (2023). *Modernizing Enterprise IT Audit Governance and Management Practices*. https://doi.org/ https://doi-org.ezproxy2.utwente.nl/10.4018/978-1-6684-8766-2

Haes, S. d., Grembergen, W. V., Joshi, A., & Huygh, T. (2019). COBIT as a Framework for Enterprise Governance of IT. *Enterprise Governance of Information Technology*.

Hay, D. (2024). Comments on Exposure Draft for Proposed ISSA 5000, sustainability assurance engagements by the Auditing and Assurance Standards Committee of AFAANZ. *Journal of Accounting & Finance*, *64*, 1221-1239.

Heijnsbergen, I. v. (2024). *A ROADMAP TOWARDS INTEGRATED CSRD REPORTING* University of Twente]. https://essay.utwente.nl/103770/

Hummel, K., & Bauernhofer, K. (2024). Consequences of sustainability reporting mandates: evidence from the EU taxonomy regulation. *accounting Forum*, *48*, 374-400. https://doi.org/https://doi.org/10.1080/01559982.2024.2301854

Hummen, K., & Jobst, D. (2024). An Overview of Corporate Sustainability Reporting Legislation in the European Union. *Accounting in Europe*, *21*(3), 320-335. https://doi.org/https://doi.org/10.1080/17449480.2024.2312145

Iamandi, I.-E., Constantin, L.-G., Munteanu, S. M., & Cernat-Gruici, B. (2019). Mapping the ESG Behavior of European Companies. A Holistic Kohonen Approach. *Sustainability 2019*, *11*. https://doi.org/10.3390/su11123276

ISACA, I. S. A. a. C. A. (2018). *COBIT 2019 Framework*. ISACA.

Joanna Krasodomska, E. Z., Donna L. Street & Wojciech Grabowski. (2025). Theimpactofcompanies'trust-building efforts on sustainability reporting assurance quality: insights from Europe. *Meditari Accountancy Research*. https://doi.org/https://www.emerald.com/insight/content/doi/10.1108/medar-05-2024-2496/full/pdf

Kirchhoff, K. R. (2024). *ESG: Sustainability as a Strategic Success Factor*. Springer. https://doi.org/https://doi.org/10.1007/978-3-658-45831-7

Lauzzana, J. (2023). *ESG Reporting: analysis of the role of technology in supporting the compliance* Ca' Foscari University of Venice].

Lorelli Nowell, J. N., Nancy Moules, Deborah White. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods*.

Luigi Operato, A. G., Erik Amaranta Eva Marion, Daniele Mattioli. (2025). Navigating CSRD reporting: Turning compliance into sustainable development with science-based metrics. *Environmental Development*, *54*. https://doi.org/https://doi.org/10.1016/j.envdev.2025.101138

Markova-Karpuzova, M., Marinov, E., & Kotzev, N. (2024). Sustainable solutions: Advancing in Tech-based ESG reproting platforms. *Proceedings of the 15th International Scientific and Practical Conference*, *1*, 235-241.

Middleton, F. (2025). Reliability vs. Validity in Research | Difference, Types and Examples.

Moeller, R. R. (2014). *Executive's Guide to COSO Internal Controls*. JHohn Wiley & Sons, Inc.

Nicola Raimo, V. L., Daniela Sica, Filippo Vitolla. (2025). Integrated reporting and the Corporate Sustainability Reporting Directive: bridging the gap or growing apart? *Management Decision*. https://doi.org/10.1108/MD-10-2024-2408

Noonan, D. (2021). *The evolution of NFRD to CSRD*. https://www.greenomy.io/nl/blog/evolution-nfrd-csrd

Olivier Boiral, Heras-Saizarbitoria, I., & Bortherton, M.-C. (2017). Assessing and Improving the Quality of Sustainability Reports:

 The Auditors' Perspective. *Journal of Business Ethices*.

Perego, P., & Kolk, A. (2012). Multinationals' Accountability on Sustainability: The Evolution of Third-party Assurance of Sustainability Reports. *Journal of Business Ethics*, *110*, 173-190. https://doi.org/https://link.springer.com/article/10.1007/s10551-012-1420-5

Pizzi, S., Mastroleo, G., Ventruelli, A., & Caputo, F. (2023). The digitalization of sustainability reporting processes:A conceptual framework. *Business Strategy and the Environment* 1-11.

Pollman, E. (2022). The Making and Meaning of ESG.

Prakash, B. (2020). *Envrionment, Social and Governance (ESG) Reporting* University of Twente].

Primec, A., & Belak, J. (2022). Sustainable CSR: Legal and Managerial Demands of the New

EULegislation (CSRD) for the Future Corporate

Governance Practices. *Sustainability 2022*, *14*.
https://doi.org/https://doi.org/10.3390/su142416648

Rout, S. (2024). Integrating IT and Financial Audits: Bridging the Gap between IT Controls and Financial Reporting *International Journal in Inovatie Reserach in Engingireeng & Multidisciplinary Physical Sciences*, *12*(6).

Ruohonen, J., & Kullas, H. (2024). The Assurance of Corporate Sustainability Reports and the Renewed Role of Certified Auditors. *European Company and Financial Law Review*, *13*. https://doi.org/https://doi.org/10.1515/ecfr-2024-0013

Schmidt, M., Nill, M., & Scholz, J. (2022). Determining the Scope 2 Emissions of Companies. *Chemical Engineering & Technology*, *45*(7), 1218-1230. https://doi.org/10.1002/ceat.202200181

Sharma, A. (2022). Meaning of 'Sustainability' with special reference to business responsibility and sustainability report. *Journal of Law, Business and Economics (JLBE)*, *1*.

Simoni, L., Bellucci, M., Acuti, D., & Manetti, G. (2019). Stakeholder engagement and dialogic accounting: Empirical evidence in sustainability reporting. *Accounting, Auditing & Accountability Journal*, *31*, 1467-1499. https://doi.org/10.1108/AAAJ-09-2017-3158

Singleton, T. (2007). The COSO Model:  How IT Auditors Can Use It to

Evaluate the Effectiveness of Internal Controls. *Information Systems Control Journal 6*.

Sonnerfeldt, A. L. L., & Pontoppidan, C. A. (2020). The Challenges of Assurance on Non-financial Reporting. *Accounting, Economics, and Law: A Convivium*, *10*(2). https://doi.org/doi:10.1515/ael-2018-0050

Sphera. (2024, Augustus 27).

Steinbart, P. J., Raschke, R. L., Gal, G., & Dilla, W. N. (2018). The influence of a good relationship between the internal audit and information security functions on information security outcomes. *Accounting, Organizations and Society*, *71*.

Stocker, F., Arruda, M. P. d., KeysaMascena, & Boaventura, J. (2020). Stakeholder engagement in sustainability reporting: A classification model. *Corporate Social Responsibility and Environmental Management*. https://doi.org/10.1002/csr.1947

Svensson, P. (2023). *Implications of the CSRD on sustainability reporting: the need for digital maturity* Shool of Industutrial Engineering and Management, Stockholm, Sweden]. https://kth.diva-portal.org/smash/record.jsf?pid=diva2%3A1767626&dswid=-2072

Tarek, M., Mohamed, E. K. A., Hussain, M. M., & Basuony, M. A. K. (2017). The implication of information technology on the audit profession in developing country: Extent of use and perceived importance. *INternational Journal of Accounting Information Systems*.

Tobin, G. (2018). Methodological rigour within a qualitative framework. *SLeading Global Nursing Research*, *48*, 388-396.

Vărzaru, A. A. (2022). An Empirical Framework for Assessment of the Effects of Digital Technologies on Sustainability Accounting and Reporting in the European Union. *Electronics*, *11*. https://doi.org/https://doi.org/10.3390/electronics11223812

Verweij, L. (2025). *What challenges do IT auditors encounter when providing limited versus*

*reasonable assurance for ESG reporting under the CSRD framework?* Tilburg University].

Yan, M., Jia, F., Chen, L., & Yan, F. (2022). Assurance process for sustainability reporting: Towards a conceptual framework. *Journal of Cleaner Production*, *377*.

Zhang, M., Shen, Q., Zhao, Z., Wang, S., & Huang, G. Q. (2024). Optimizing ESG reporting: Innovating with E-BERT models in nature language processing. *Expert Systems with Applications*, *265*. https://doi.org/https://doi.org/10.1016/j.eswa.2024.125931

Zumente, I., & Bistrova, J. (2021). ESGImportance for Long-Term Shareholder Value Creation:

Literature vs. Practice. *Journal of Open Innovation: Technology, Market and Complexity*, *7*.

# Appendix 1: Problem Structure

The figure below illustrates the core structure of the research problem addressed in this thesis. This figure was developed to provide an overview of how different elements in ESG reporting, data gathering technologies and IT auditing relate under the CSRD.
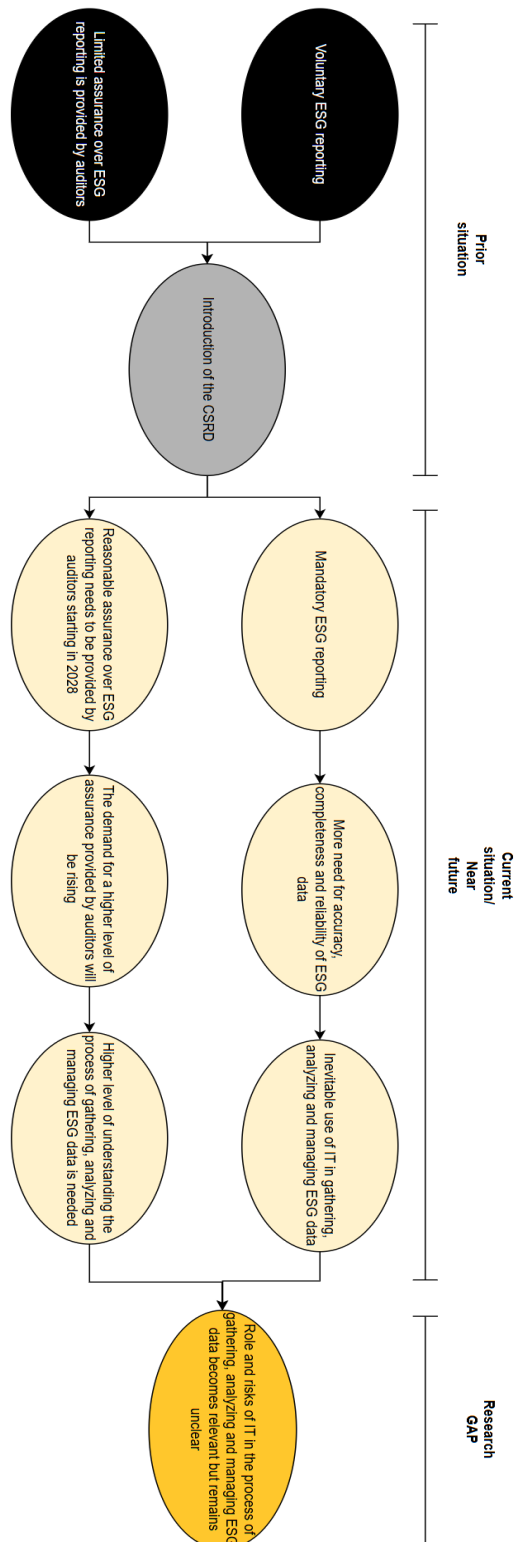


*Figure 7: Problem structure*

# Appendix 2: Interview Guide

This appendix contains the interview guides used during the semi-structured interviews for this study. Three tailored guides were developed to reflect the different backgrounds and expertise of the respondent groups:

1. Climate Change and Sustainability Services (CCaSS) specialists
2. IT auditors
3. Professionals with expertise in both IT and ESG assurance

## Interview guide respondent group 1 CCaSS semi-structured interviews

**Introduction to the interview**

1. What is your current role within your organization?

    - How long have you been in this role?

2. Could you briefly describe your main responsibilities and daily tasks?

**ESG and CSRD Reporting**

3. Could you briefly explain how you are involved in ESG/CSRD reporting?

    - How long have you been involved in ESG/CSRD reporting?

    - What specific tasks do you perform related to ESG/CSRD reporting?

4. What are the most common key requirements of the CSRD for the companies you asses?

    - Are these requirements generally consistent across companies, or do they vary significantly? And if so, how?

    - Do these requirements differ significantly between companies, or are they generally consistent? And if so, how?

5. What criteria do you use, and/or what are key requirements/risks, you asses when providing assurance on ESG reports according to the CSRD?

**The Role of IT / Data Gathering Technologies in ESG/CSRD Reporting**

6. How do you see IT being utilized by clients? And perhaps in your own work as well?

    - In which reporting areas does IT play the most significant role? (e.g., certain ESRS topics)

    - In which parts of the CSRD compliance process does IT contribute the most?

7. What is your perspective on the role of data gathering technologies (ERP systems & IoT) in ESG/CSRD reporting?

    - Do you see ERP and IoT systems already being used for ESG reporting? If so, in what way?

    - How do these technologies help ensure the accuracy, completeness, and reliability of ESG-data?

- Do you think companies are sufficiently leveraging these systems for ESG reporting and assurance? And if yes or no, why?

**Common IT risks**

8. Are there general risks associated with the role of IT in ESG/CSRD reporting?
   - How are these risks being identified and assessed?
   - Do you often identify the same risks, or do they vary significantly between companies? How do these IT-related risks influence the assurance work you perform? And are these risks already being mitigated in practice?
9. What are the key risks associated with the use of ERP systems and IoT devices in ESG/CSRD reporting?
   - How do you identify and assess IT-related risks in these technologies?
   - Do these risks tend to be more company-specific, or do you see recurring patterns?

**Future of IT(-audit) in ESG reporting**

10. Looking ahead, how do you see the future of ESG reporting in relation to IT?
    - How do you think the use of data gathering technologies in ESG assurance will evolve?
    - Do you foresee new challenges emerging as IT-driven ESG reporting expands? And if so, what kind of challenges?
    - Are you familiar with the work from an IT auditor? And from your perspective, how could IT- uditors and CCaSS professionals collaborate more effectively to enhance ESG assurance?

**Relevant cases**

11. Would you recommend any clients in your portfolio as potential case study for further exploration in the interviews?
    - Are there companies that already heavily rely on IT (like ERP and IoT) for ESG-data collection and reporting? And if so, how?
    - Do you see specific cases where IT introduces notable risks that need to be addressed in assurance work? If so, can you elaborate further?
    - Or are there other cases where absence or minimal use of IT in ESG reporting presents unique challenges, making them valuable to explore in the dyadic interviews?

## Interview guide respondent group 2 IT audit semi structured interviews

**Background & Role of the Respondent**

1. What is your current role within your organization?

2. How long have you been working in IT, and specifically in ESG reporting or assurance?

3. Could you briefly describe your main responsibilities and daily tasks in relation to ESG reporting and compliance?

**The Role of IT in ESG Reporting & CSRD Compliance**

4. How do you see IT being utilized by companies in ESG reporting?

5. Which aspects of ESG reporting do you believe IT plays the most significant role in? (E.g., E, S, or G elements?)

6. To what extent do companies rely on IT systems (such as ERP or IoT devices) for ESG-data collection and processing?

7. How do companies currently structure their ESG reporting processes? How does IT factor into these processes?

8. From your perspective, how effectively do companies integrate IT into their ESG reporting? What challenges do they face?

**Data Collection & Processing**

9. How do companies typically collect ESG-related data? Do they rely on automated systems, manual entry (e.g., Excel), or a combination of both?

10. For which ESG metrics do companies most commonly utilize IT solutions? Are quantitative data (e.g., environmental emissions) better supported by IT than qualitative data?

11. What is your perspective on the accuracy and reliability of ESG-data generated through IT systems versus manual processes?

12. Can you describe a typical workflow for ESG-data collection and analysis from an IT perspective?

13. How is IT used to ensure data quality, consistency, and traceability in ESG reporting?

**Common IT Challenges & Risks in ESG Reporting**

14. What are the most common challenges companies face in integrating IT into ESG reporting?

15. What are the key risks associated with using IT systems for ESG-data collection and reporting? (e.g., lack of standardization, human error, data integrity issues, security concerns, etc.)

16. Are there specific risks that arise when using ERP systems or IoT devices for ESG-data management?

17. How do companies currently address these risks? Are there best practices for mitigating IT-related risks in ESG reporting?

18. Do companies implement internal controls to validate ESG-data generated by IT systems? If so, how?

**Future of IT in ESG Reporting & Assurance**

19. Looking ahead, how do you see the role of IT evolving in ESG reporting and compliance?

20. Do you foresee new challenges emerging as companies increase their reliance on IT for ESG reporting? If so, what kind of challenges?

21. What role do you think IT auditors should play in the ESG reporting process?

22. How could IT auditors and ESG assurance professionals collaborate more effectively to enhance the reliability and credibility of ESG reports?

**Closing Questions & Additional Insights**

27. Is there anything else you believe is important to consider when looking at IT's role in ESG reporting?

28. Do you have any recommendations for improving IT integration into ESG assurance and compliance?

## Interview guide respondent group 3 IT and ESG specialists

**Background & Role**

1. What is your current role within the organization?

2. What is your experience in the field of IT audit and ESG-related engagements?

**Use of IT in ESG Reporting**

*Goal: verify how IT systems are being utilized in ESG reporting and which systems are most relevant.*

3. How do you see IT systems (e.g., ERP, IoT) being used for ESG-data collection and reporting?

4. In your experience, are these systems mainly used for environmental, social, or governance data?

5. Are companies relying more on automated systems or manual processes (e.g., Excel)?

6. To what extent do you see structured workflows for ESG-data collection across clients?

7. From your audit perspective, what is your impression of data **quality** and **traceability**?

## 3. Risks, Challenges & Internal Controls

*Goal: zoom in on IT-related risks in ESG reporting and the auditor's role.*

8. What common IT-related challenges do you encounter in ESG reporting audits?

9. What risks do you associate with systems like ERP or IoT (e.g., lack of standardization, integrity issues, traceability)?

10. Do you observe that companies implement proper **internal controls** to validate ESG-related IT data?

11. In your view, are clients sufficiently aware of these IT-related risks in ESG reporting?

## Future of IT & IT Audit in ESG

12. How do you see the role of IT evolving in ESG reporting in the coming years?

13. What role should IT auditors ideally play in the ESG assurance process?

14. From your experience, how could collaboration between IT auditors and ESG reporting/assurance professionals be improved?

## Closing Questions

15. Are there any best practices you've seen that might serve as a good example of IT-enabled ESG reporting?

16. Do you have any additional insights or recommendations that could help strengthen IT's contribution to reliable ESG reporting?

# Appendix 3: Coding Scheme

This appendix presents the complete coding scheme developed through the Gioia methodology. It includes the first-order concepts, second-order themes, and aggregate dimensions that have been derived from the semi-structured interviews.

| First Order Concepts | Second-order themes | Aggregate dimensions |
|---|---|---|
| Reliance on Excel for ESG reporting | Immature and fragmented ESG Tooling | Limited digital integration in ESG-data gathering |
| Lack of ownership for ESG-related IT systems | | |
| Multiple disconnected systems and manual extraction | | |
| | | |
| Use of off-the-shelf, in-house, and hybrid system | Diverse technology approaches across organizations | |
| Tool choice is often driven by internal IT maturity | | |
| | | |
| Prevalence of manual data entry | Slow adoption of automation and direct measurement | |
| Reliance on proxies instead of real-time data | | |
| Limited use of sensor-based or IoT-driven metrics | | |

| First Order Concepts | Second-order themes | Aggregate dimensions |
|---|---|---|
| Manual adjustments bypass system checks | Weak control over manual data changes | Limited maturity of data gathering technologies in ESG reporting creates risks |
| Risk of undetected modifications | | |
| Lack of validation mechanisms | | |
| | | |
| Limited enforcement of segregation of duties | Inadequate access and authorization procedures | |
| Lack of clear ownership or access policies | | |
| | | |
| Fragmented tooling landscape | Immature ESG-specific tooling and integration | |
| Existing ERP tools not tailored to ESG | | |
| Lack of robustness of IT in ESG context | | |
| | | |
| Data originates from many disconnected sources | Data flow complexity complicates assurance & Challenges in ESG-data mapping | Complexity of ESG-data and the IT landscape |
| Limited visibility into how ESG-data flows between systems and departments | | |
| Manual integrations obscure data lineage | | |
| Dynamic reporting structures hinder consistency | | |

| First Order Concepts | Second-order themes | Aggregate dimensions |
|---|---|---|
| Centralization of ESG-data through ERP systems | Improved accuracy and standardization through data gathering technologies | Improving ESG-Data Quality for Assurance through Data Gathering Technologies |
| Use of templates and predefined formats | | |
| Reduction in human error through automation | | |
| | | |
| Real-time monitoring of ESG indicators | Increased efficiency and control through data gathering technologies | |
| Faster reporting cycles through automated data flows | | |
| Improved internal governance and traceability | | |
| | | |
| Limited assurance leads to less formalized assurance processes | Establishing structured governance for aligned and rigorous ESG assurance | |
| Lack of clear ESG-specific control frameworks | | |
| Governance in ESG is still maturing | | |
| Future shift to reasonable assurance increases need for IT controls | | |

| First Order Concepts | Second-order themes | Aggregate dimensions |
|---|---|---|
| ESG-related IT systems fall outside current audit scope | Limited assurance scope restricts technical validation | Limited maturity of IT assurance in ESG context |
| Low testing depth limits assurance quality | | |
| Lack of IT expertise in ESG audits | | |
| | | |
| No ESG-specific IT audit approach exists yet | Lack of structured IT evaluation frameworks in ESG context | |
| Frameworks are being borrowed from financial audits | | |
| | | |
| Emphasis on data flow over system mechanics | Process-focused audits in ESG reporting with limited IT system assessment | |
| Limited technical system validation | | |
| | | |
| Uncertainty about evolving regulations | Regulatory uncertainty impacts collaboration needs | Aligning IT Audit and ESG Assurance Practices for Technology Evaluation in an ESG context |
| Collaboration needed to adapt to changing regulations | | |
| Changes in reporting guidelines require frequent updates | | |

| | | |
|---|---|---|
| Differentiation between limited and reasonable assurance | Absence of reasonable assurance limits IT audit involvement | |
| IT audit limitations under limited assurance | | |
| | | |
| Lack of structured frameworks for auditing ESG application controls | Limited focus on application controls in ESG practice | |
| Minimal assessment of ESG application controls | | |
| Prioritization of ESG-data over technical controls | | |
| | | |
| Interdepartmental communication ensures consistency in reporting | Process-oriented collaboration remains key | |
| Need for process alignment across departments | | |
| Collaboration is needed to ensure transparency and accountability in ESG reporting | | |