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How Corporations Operationalize Climate-Related Risks and Opportunities: Evidence From Qualitative Expert Interviews

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ABSTRACT

Climate-related risks and opportunities have become a central concern for companies as climate change increasingly affects business models, value chains, and long-term competitiveness. However, limited evidence exists about how corporations confront the attendant practical and strategic challenges of climate-related risk and opportunity disclosure. Empirical evidence remains limited on how firms confront the practical and strategic challenges of responding to growing regulatory and stakeholder expectations embedded in climate-related reporting frameworks, such as the TCFD. Addressing this gap, this study investigates how organizations interpret and operationalize these rising expectations in practice. We conducted eight semi-structured interviews with sustainability professionals across industries and analyzed the data using the GABEK method in WinRelan to map expert perspectives and infer underlying meaning structures. Findings indicate that the TCFD has become the primary reference framework for risk- and opportunity-related reporting, yet organizational approaches remain heterogeneous and largely nascent. Most companies emphasize risk avoidance and regulatory compliance over opportunity-oriented innovation. The study highlights three interrelated domains that function as both enablers and barriers to effective climate-related reporting and climate resilience, namely (1) stakeholder dynamics; (2) implementation maturity and institutionalization; (3) data availability, quality, and integration; and (4) organizational governance and structural embedding. The findings contribute to the literature by shedding light on the organizational conditions under which climate-related reporting frameworks are translated into practice, highlighting persistent gaps between formal disclosure requirements and substantive implementation.

1 | Introduction

Climate-related sustainability reporting has gained significant importance in recent years (Gulluscio et al. 2020). In particular, the *Task Force on Climate-related Financial Disclosures* (TCFD) has played a crucial role in shaping corporate climate reporting, establishing a widely recognized framework for assessing and disclosing *climate-related risks and opportunities* (CRO). Although the Task Force on Climate-Related Financial Disclosures (TCFD) has formally concluded its mandate, its conceptual architecture continues to underpin global climate reporting, having been fully incorporated into the standards issued by the International Sustainability Standards Board (ISSB). Nevertheless, the term TCFD is still widely used. As a reporting standard, TCFD has provided companies with structured guidelines to integrate climate considerations into their financial and strategic planning, thus fostering greater corporate accountability and resilience (Xhindole et al. 2025). With the introduction of the *Corporate Sustainability Reporting Directive* (CSRD) by the European Union in 2023, the relevance of climate-related

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reporting has further increased. The CSRD builds upon and incorporates the principles of TCFD, making climate risk and opportunity assessments a mandatory component of corporate sustainability disclosures. Companies subject to this reporting obligation are required to provide comprehensive information on their environmental and climate impacts, aligning with TCFD's risk-based approach. This regulatory tightening aims to enhance transparency, provide investors and stakeholders with a solid basis for decision-making, and ultimately contribute to achieving the European climate targets (cf. Oliver Yébenes 2024).[1]

Reporting on climate-related sustainability presents crucial challenges for companies, as it is increasingly under the evaluation of various stakeholders. Investors, customers and regulatory authorities expect companies not only to provide transparency regarding their environmental impact but also to outline a clear strategy for addressing the challenges posed by climate change (Arian and Sands 2024). A central aspect in this context is *climate resilience*, i.e., the ability of a company to adapt to climatic changes, minimize risks, and maintain long-term competitiveness (Yadav and Pandey 2024). The growing importance of climate risks therefore necessitates not only detailed reporting but also the strategic integration of climate-related measures into corporate governance to ensure sustainable value creation and regulatory compliance. The successful integration of climate-related measures into corporate governance requires a profound understanding of CRO. Companies must not only identify potential *physical* and *transition* risks but also recognize strategic opportunities that arise from the shift toward a low-carbon economy (Gao, Dong, and Liu 2024; Gao, Dong, et al. 2024). Ultimately, this information also serves as a basis for evaluation by external stakeholders, such as in the assessment of the sustainability performance of investment funds; an aspect that is increasingly critical to a company's financial performance (Popescu et al. 2021).

A well-founded *climate risk and opportunity analysis* serves as the foundation for an effective sustainability strategy. It enables companies to proactively identify climate-related threats, such as extreme weather events, regulatory changes, or shifting market demands and implement targeted measures to mitigate risks. At the same time, it presents opportunities to gain competitive advantages through innovative technologies, more efficient resource utilization, and the development of sustainable business models (cf. Yin, Tan, et al. 2025). Climate disclosure, therefore, requires not only a retrospective disclosure of sustainability metrics but also a forward-looking assessment of climate resilience. However, studies from countries where climate-related reporting has been mandatory for a longer period, for example, the United Kingdom (Section 2), indicate that the relevance of climate-related disclosure is increasingly acknowledged. Nevertheless, disclosures often remain incomplete and inconsistent, suggesting that significant challenges persist in practices (Borghei et al. 2024). Yet, there is still little research on the specific nature of these challenges and the obstacles companies face in climate risk reporting.

This research project aims to investigate the central research question:

> How do companies perceive, interpret and operationalize climate-related risks and opportunities in the context of TCFD-aligned sustainability reporting, and how are these processes shaped by organizational structures, data practices and stakeholder interactions?

In light of increasing regulatory requirements and rising stakeholder expectations, companies must not only address the risks associated with climate change but also identify opportunities arising from the transition to sustainability. This study examines both the practical challenges in implementing the CSRD directive and the strategic opportunities that emerge from a systematic approach to climate-related reporting.

Despite the prominent role of the TCFD framework in global climate-related financial reporting, recent systematic reviews demonstrate that the academic discourse remains predominantly theoretical in nature, with only limited empirical insights into how organizations substantively operationalize climate-related risks and opportunities in practice, and which internal structural or procedural barriers shape implementation outcomes (Tumewang et al. 2025). Moreover, comparative disclosure analyses reveal a pronounced heterogeneity in the quality, completeness, and strategic depth of TCFD-aligned reporting, ranging from minimal, compliance-oriented statements to highly elaborated and strategically embedded disclosures (TCFD 2022). In addition, empirical research identifies governance-related determinants as central drivers of climate transparency (Jeanne et al. 2023) and documents the prevalence of selective disclosure practices, including the use of boilerplate language or "cheap talk," particularly in voluntary climate-risk reporting (Bingler et al. 2022). Against this backdrop, the present study contributes to the literature by offering rare, practice-proximate qualitative evidence on how companies perceive, interpret, and operationalize TCFD-aligned assessments of climate-related risks and opportunities under emerging regulatory and stakeholder pressure. Drawing on in-depth expert interviews, the analysis identifies the organizational, data-related, and stakeholder-driven barriers that mediate the translation of regulatory expectations into internal managerial processes. This qualitative perspective complements existing quantitative and disclosure-based studies and provides novel insights into the early institutionalization and practical enactment of climate-related risk analysis within corporate structures.

Therefore, this research paper examines how companies' practical challenges are associated with their implementation and the strategic benefits of proactive climate reporting, based on qualitative expert interviews. Specifically, it investigates the challenges of transitional change, the management of CROs, as well as the role of stakeholders and data management systems. Our study also draws on strategic and institutional perspectives by acknowledging that corporate responses to climate-related reporting requirements are shaped by institutional pressures, organizational capabilities, and legitimacy-seeking behavior. The findings suggest that companies should adopt a climate strategy that extends beyond regulatory compliance and reporting. The proactive integration of climate

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risks into business models, the implementation of systematic data collection processes, and transparent stakeholder engagement are critical factors that not only can facilitate the transition but also enhance long-term economic resilience and sustainable value creation.

The structure of this paper is as follows: Section 2 provides an overview of the TCFD framework and examines key aspects of climate-related reporting. Section 3 outlines the qualitative database derived from expert interviews and describes the methodological approach. The findings are presented in Section 4, followed by a critical discussion in Section 5, which contextualizes the results within the broader objective of climate resilience.

2 | Climate Resilience as a Strategic Imperative: The Role of Climate Risk and Opportunity Analysis in Regulatory and Stakeholder Contexts

In the face of accelerating climate change, climate resilience has emerged as a critical concern for a wide range of stakeholders, including investors, regulators, customers, and civil society actors. Stakeholders increasingly expect companies not only to disclose their environmental impacts but also to demonstrate how they assess and manage climate-related risks to maintain long-term viability and value creation (Averchenkova et al. 2016). As such, a comprehensive climate risk analysis, which also includes the analysis of opportunities, has become a strategic necessity. It enables corporations to identify, evaluate, and respond to both physical risks (e.g., extreme weather events, sea level rise) and transition risks (e.g., regulatory shifts, market changes, technological disruption), thereby strengthening their adaptive capacity and competitiveness (Elijido-Ten and Clarkson 2019; Li et al. 2024). Although the TCFD has evolved into the globally dominant reference framework for climate-related financial disclosure, empirical evidence indicates that its organizational implementation remains uneven and methodologically fragmented. Systematic literature reviews demonstrate that most TCFD-related research and reporting practices remain strongly descriptive, offering limited insight into how organizations substantively integrate climate-related risks and opportunities into strategic decision-making processes (Tumewang et al. 2025). Complementary analyses of disclosure quality reveal pronounced heterogeneity in the completeness and strategic depth of TCFD-aligned reporting, with only a small share of firms providing information that fully meets all 11 recommended TCFD disclosures (TCFD 2022). These findings demonstrate that the institutionalization of TCFD-aligned, climate-risk analysis is still at an early stage and constrained by organizational and methodological limitations. From an institutional perspective, the increasing adoption of TCFD-aligned disclosure practices reflects growing stakeholder pressures documented in sustainability reporting research (Amoako et al. 2021). At the same time, responding effectively to climate-related risks requires dynamic capabilities that allow firms to sense, assess, and adapt to uncertainty, as highlighted by research linking organizational capabilities to climate-risk disclosure readiness (Howard-Grenville et al. 2014). Moreover, climate-risk disclosure serves important legitimacy functions, enabling firms to demonstrate conformity with societal and stakeholder expectations (Tumewang et al. 2025).

In addition, companies that disclose climate-related risks, particularly in line with the TCFD framework, tend to experience a crucial positive effect on their market performance (Gupta 2025; Vestrelli et al. 2024). Transparency is rewarded by investors through increased trust and reduced cost of capital (Ghose et al. 2025). Recent empirical contributions deepen this understanding by identifying governance structures, environmental performance, and regulatory pressure as central determinants of climate-risk transparency (Jeanne et al. 2023). At the same time, textual analyses of voluntary climate-risk reporting reveal pervasive tendencies toward selective disclosure and the use of boilerplate language or "cheap talk," raising concerns about the informational value and decision-usefulness of TCFD-aligned disclosures (Bingler et al. 2022). These insights suggest that firms frequently adopt disclosure practices that symbolically meet external expectations without substantively improving their internal climate-risk management capabilities. Moreover, climate-related disclosures are associated with a greater capacity for sustainable innovation and facilitate corporate adaptation to tightening environmental regulations. Such disclosures also contribute to improved corporate governance. By systematically assessing climate risks, such as through scenario analysis, managers are better equipped to integrate climate considerations into strategic decision-making and to communicate the resilience of their business models more effectively (Gao, Saleh, et al. 2024).

Cross-country comparative research also indicates that the maturity and quality of TCFD-aligned reporting vary substantially across national contexts. A comparative analysis of Italy and Spain reveals marked differences in firms' disclosure depth, scenario-analysis practices, and governance-related climate transparency, despite shared exposure to the broader European regulatory environment (Xhindole et al. 2025). The authors attribute these divergences to differing institutional pressures, reporting traditions, and organizational capabilities, underscoring that the adoption and operationalization of the TCFD recommendations are far from homogeneous across jurisdictions. These findings reinforce the importance of context-sensitive research when examining corporate climate-risk reporting. This expectation is embedded in key regulatory frameworks, for example, both the CSRD and the EU Taxonomy Regulation explicitly call for companies to assess and disclose CRO. In parallel, the United Kingdom has already introduced mandatory TCFD-aligned reporting for more than 1300 large companies and financial institutions, making it one of the earliest jurisdictions to require legally enforceable climate-risk disclosure across corporate and financial sectors (UK Government 2021). Moreover, an increasing number of countries, including New Zealand, Japan, Canada, Singapore, and Brazil, are adopting or preparing mandatory TCFD-aligned regimes, which substantially heighten stakeholder expectations and intensify global pressure for robust, forward-looking climate-risk reporting (TCFD 2023). These regulatory pressures emphasize the need for forward-looking, scenario-based analyses, which inform strategic decision-making and capital allocation. Climate resilience is, therefore, no longer a voluntary component of corporate responsibility, but a binding element of compliance with European sustainability standards (Andersson and Arvidsson 2022; Velte 2024). Beyond empirical evidence, conceptual research emphasizes the need for a more integrated theoretical foundation for

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climate-related disclosure. Alam and Costa (2025) develop a comprehensive conceptual framework for climate-change disclosure and argue that current reporting practices—including those aligned with the TCFD—often lack a coherent linkage between risk identification, governance mechanisms, managerial decision-making, and stakeholder information needs. They highlight unresolved questions regarding the cognitive, institutional, and capability-related drivers of substantive climate-risk disclosure and call for research that examines how organizational structures and internal processes shape the depth and credibility of climate-related reporting. This perspective underscores the need for qualitative insights into how climate-risk information is produced, interpreted, and embedded in corporate practice (Section 3).

The TCFD, in supporting companies in meeting these requirements, developed a widely adopted framework that offers structured guidance for identifying and reporting climate-related financial risks. The TCFD recommendations, introduced in 2017, are organized around four thematic pillars: governance, strategy, risk management, metrics and targets. These elements are, for example, integrated into the *European Sustainability Reporting Standards* (ESRS), which operationalize the CSRD (Demaria and Rigot 2021).

The TCFD framework differentiates between physical risks and transition risks. *Physical risks* arise from acute events such as extreme weather (e.g., storms, floods, heatwaves) as well as chronic changes such as rising sea levels or long-term shifts in climate patterns. These risks can disrupt supply chains, damage infrastructure, or affect resource availability. *Transition risks*, on the other hand, stem from the societal and regulatory shifts toward a low-carbon economy. These include policy changes (e.g., carbon pricing), technological innovations, shifts in market demand and reputational concerns. These risks ultimately reflect the *significant external pressure* companies face in achieving their climate targets (Tolonen 2024). In addition to identifying risks, the TCFD framework encourages companies to assess climate-related opportunities, for example, the development of low-emission products, increased energy efficiency, improved resilience of supply chains, or access to new markets. By analyzing both risks and opportunities, companies can better align their strategies with long-term climate objectives while enhancing their competitiveness and investment appeal (TCFD 2017).

Despite its strategic value, the implementation of the TCFD framework presents significant challenges for companies, particularly in the areas of data availability, methodological complexity, and internal organizational readiness. One of the primary difficulties is reflected in the quantification and scenario-based assessment of CRO, especially over long-time horizons marked by high uncertainty. Many companies lack access to reliable, granular climate data or face difficulties in translating physical and transitional risks into financial terms through robust modeling approaches. Moreover, integrating climate considerations into existing governance and risk management systems often requires cross-functional collaboration, new internal processes and the development of climate-specific expertise. This can be particularly demanding for small- and medium-sized enterprises or organizations with limited sustainability infrastructure.[2]

The absence of standardized metrics and harmonized disclosure practices further complicates implementation and limits comparability across industries and markets (CISL 2022; Lee et al. 2024; Torvanger et al. 2024). Another important challenge is driven by a lack of internal prioritization of climate risk analysis. In many cases, climate-related reporting is still perceived as a compliance exercise rather than a strategic tool for long-term resilience and value creation, which is also related to the acceptability and voluntary nature of the TCFD standard (Cradduck et al. 2023). As a result, firms may implement TCFD recommendations in a fragmented or superficial manner, limiting the effectiveness and credibility of disclosures. Additionally, concerns over reputational risks, investor reactions, or competitive disadvantages can lead to reluctance in publishing forward-looking or scenario-based information (Unda and Foerster 2022). These challenges underscore the need for capacity-building measures, clearer regulatory guidance, and a shift in organizational mindset from compliance-driven reporting to integrated, future-oriented risk and opportunity management. Only with increasing internal acceptance and stronger external incentives can the full potential of climate risk analysis based on the TCFD be exploited (Ghose et al. 2025). Moreover, there is a need for data-driven risk analyses, an area in which many companies still lack an appropriate approach. Common methods of analyses tend to focus primarily on physical risks (Chiu et al. 2023).

In summary, climate risk analysis functions as both a compliance mechanism and a strategic management tool. It enhances transparency, aligns corporate action with stakeholder expectations, and fosters resilience in an era of profound environmental and regulatory transformation. However, despite growing regulatory pressure and widespread adoption of the TCFD framework, empirical insights into how companies concretely experience and address these challenges remain limited. Systematic research, to date, on the practical implementation barriers, internal dynamics, and organizational perceptions of climate risk analysis is scarce, highlighting the need for further investigation in this emerging field.

3 | Data and Method

This study employs a qualitative research design, based on semi-structured expert interviews, to explore the challenges and opportunities associated with climate-related sustainability reporting under the CSRD. Interviews are widely recognized in qualitative research (Qu and Dumay 2011), and semi-structured interviews, in particular, (Taylor 2005; DiCicco-Bloom and Crabtree 2006) as facilitating a balanced structured inquiry with exploratory depth, which allows researchers to identify themes beyond predefined categories (Qu and Dumay 2011). Although the TCFD framework has become a dominant reference basis for climate-related financial reporting, systematic reviews show that existing research remains largely theoretically and conceptually focused, offering only limited insight into how organizations practically implement and internalize climate-related risk and opportunity assessments (Tumewang et al. 2025). Empirical disclosure analyses further document pronounced heterogeneity in the quality and strategic depth of TCFD-aligned reporting (TCFD 2022). The present study, therefore, contributes empirical, practice-proximate qualitative

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TABLE 1 | Overview of the companies surveyed and interviewees.

Companies surveyed			Interviewees		
Designation	**Industry**	**Number of employees**	**Position and expertise of the interviewees in the field of sustainability**	**Interview length**	**TCFD reporting status**
I	Manufacturing Service Provider for Electronic Components (Producer)	13.000	Director of Environment, Health and Safety; 14 years	44 min	Final analysis
II	Mechanical Engineering (Producer)	5.000	Manager Sustainability, Environment and Energy; 2.5 years	38 min	In progress
III	Mechanical Engineering (Producer)	3.600	Sustainability Manager; 2.5 years	30 min	In progress
IV	Transport and Logistics (Service Provider)	18.000	Sustainability Manager; 2.5 years	30 min	In progress
V	Plant Engineering (Producer)	9.100	Sustainability Manager; 5.5 years	40 min	Final analysis
VI	Consumer Goods in the Cosmetics and Health Sector (Producer)	250	1. Sustainability Manager; 3.5 years 2. Risk Manager; 1.5 years	50 min	Final analysis
VII	Automotive Industry (Producer)	4.600	Sustainability Manager; 18 years	40 min	In progress
VIII	Sustainability Consulting (Service Provider)	50	Sustainability Consultant; 2 years	25 min	In progress

evidence on the organizational, data-related, and stakeholder-driven barriers shaping the operationalization of climate-related risk analysis. Given the complexity of regulatory compliance and corporate climate risk management, this methodological approach ensures both comparability and flexibility in data collection.

A total of eight expert interviews were conducted via video call with sustainability professionals across various industries (Table 1). The selection criteria required that participating organizations, all based in Germany, either were already subject to TCFD-related obligations at the time of the interviews, were expected to become subject to such obligations soon, or operated as consulting firms providing advisory services in the TCFD/climate-disclosure field. All interviews were conducted at the end of 2024, prior to the implementation of the Omnibus package proposed by the European Commission. The objective was to capture varying degrees of progress in TCFD implementation across organizations of different sizes, sectors, and stages of preparedness.

The interviewees from each company were selected based on one of these three key criteria: prior experience with climate-related reporting, engagement in TCFD-aligned projects, or obligation to report under the CSRD framework. By leveraging expert knowledge in sustainability reporting, this methodological approach provides a nuanced understanding of corporate adaptation to evolving regulatory and stakeholder expectations. The findings contribute to the discourse on corporate climate resilience by elucidating both barriers and strategic responses to the increasing demands of climate-related disclosure.

The interviews were guided by a set of overarching questions to preserve the semi-structured nature of the interviews and to encourage open, undirected responses: (1) *What is the current status of climate-related disclosure in your organization?* (2) *Where do you see key challenges in this area?* and (3) *How do you address climate-related risks and opportunities?* No predefined answers were provided. Instead, interviewees were encouraged to speak freely about the aspects they considered most relevant to the topic. Together, these questions form a comprehensive framework for understanding the current obstacles and opportunities that companies face when implementing climate-related sustainability reporting.

This study employs the qualitative *GABEK* method (*Ganzheitliche Bewältigung von Komplexität*) in combination with the *WinRelan* software (*Windows Relationen Analyse*) to systematically analyze and structure expert insights. The *GABEK* method is an established qualitative and exploratory research approach designed for the systematic preparation, structuring, and analysis of verbalized knowledge, attitudes, and experiences. Its core purpose is to reduce the complexity of phenomena, enabling a deeper understanding of their intricacies by exploring and contextualizing subjective perceptions and interpretations. *GABEK* enables the examination of knowledge, attitudes, and cognitive associations of individuals and organizations concerning a specific topic, allowing for their contextualization and the identification of shared

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patterns of thought and uncovering shared ways of thinking and associations across a given topic (Zelger 2019; Zelger and Oberprantacher 2002).

Unlike purely syntactic text analyses, the *GABEK* approach emphasizes the semantic dimension, capturing meaning and relationships embedded within the data (Raich et al. 2014; Zelger 2000, 2004). *GABEK* was primarily used to analyze and link knowledge of different experts, identifying associative patterns (Mardenli, Sackmann, et al. 2025). More recently, its application has expanded to diverse research contexts, including interview analysis and sustainability reports (e.g., Hielscher and Will 2014; Mardenli et al. 2023; Rhein and Sträter 2021; Schultz and Reinhardt 2022).

The data analysis using the *GABEK* method is carried out in several precise steps, supported by the rule-based software tool *WinRelan*, which ensures a transparent and reproducible analysis process. First, the collected textual data, such as from interviews or reports, is processed and content-relevant passages are extracted. In the second step, the entire text is divided into so-called units of sense. Each unit represents a distinct idea and typically consists of a few sentences, which are stored on separate digital index cards in *WinRelan*.

Subsequently, each unit is manually coded: "Keywords" are assigned that reflect the core content of the unit. Care is taken to avoid synonyms and to standardize singular and plural forms. Keywords that appear together within a single meaning unit are considered to be associatively linked (Zelger 2000, 2004; Raich et al. 2014).

Accordingly, the method reveals common thought patterns of people who speak independently of each other about a certain topic and, thus, identifies which aspects are jointly regarded as relevant.

In the specific research context, this means: what do the interviewed experts think when they talk about climate disclosure? The aspects identified in the results section thus represent, for example, the challenges that are commonly perceived by these experts.

Once coded, *WinRelan* extracts associative relationships between key terms across the dataset, visualized through network graphs. These network graphs are presented in the following section of this study. Keywords that frequently co-occur within the same unit of sense are linked by connecting lines, illustrating associations or interconnections in expert perspectives and corporate sustainability strategies. This approach enables both thematic clustering and in-depth analysis of individual statements, ensuring traceability and methodological rigor (Zelger 2000; Rhein and Schmid 2020; Rhein and Sträter 2021).

It is useful, to maintain conceptual clarity, to situate *GABEK* with its software *WinRelan*, within the broader landscape of qualitative research methodologies and software-supported analytical approaches. Though both grounded theory and *GABEK* are qualitative and inductive approaches, they function at different levels in research. Grounded Theory provides a broad framework for guiding the entire research process, whereas *GABEK* offers a structured, rule-based method specifically for organizing and analyzing textual data (Mardenli, Sträter, et al. 2025).

This study also employs the *GABEK* method and *WinRelan* software to ensure that meaning-making remains grounded in human interpretation, thereby avoiding the risks associated with AI-driven qualitative analysis. Unlike tools that increasingly automate coding via AI, GABEK's manual, rule-based procedure ensures that the researcher remains the central sense-maker. This approach preserves the necessary context and ensures an authentic representation of participant voices, preventing the superficiality often associated with AI-generated results (Paulus and Marone 2024). Furthermore, the distinction between *GABEK* and conventional QDA tools is reflected in its inherent methodological rigidity. Whereas software like MAXQDA or NVivo allows a separation of coding and a strict application of methods, *GABEK*, with its software *WinRelan*, mandates a rule-based linguistic integration where the analysis is inseparable from the software's structural logic (Buber and Kraler 2000). This procedural entanglement acts as a safeguard against AI-driven analysis, ensuring that every conceptual link in the final network graphs is grounded in authentic, human-verified, and method-based discourse.

As most interviews were conducted in German, coding was performed in the original language to maintain linguistic accuracy and contextual integrity (Abfalter et al. 2021). However, the results were translated into English for presentation and discussion.

4 | Results

The following section presents the results of the interview analysis and explains the corresponding association network graphs. All interview participants made statements regarding the TCFD as a widely recognized standard for the analysis of CRO (Figure 1). These statements serve as the analytical starting point and provide an initial overview of the associations linked to the topic of climate risks and opportunities within the dataset.

Some of the interviewed experts reported that, although they have not yet conducted a formal TCFD analysis, climate-related risks are already considered within their internal risk management processes. As one respondent described:

> "So in the area of TCFD, we are not yet set up as required by the CSRD. We do have an internal risk-opportunity management, yes [...]"
>
> (Interview III)

Overall, the associations with TCFD reveal heterogeneous approaches to the analysis of CRO, with notable differences among respondents depending on whether they had previously implemented TCFD or addressed climate issues through alternative frameworks.

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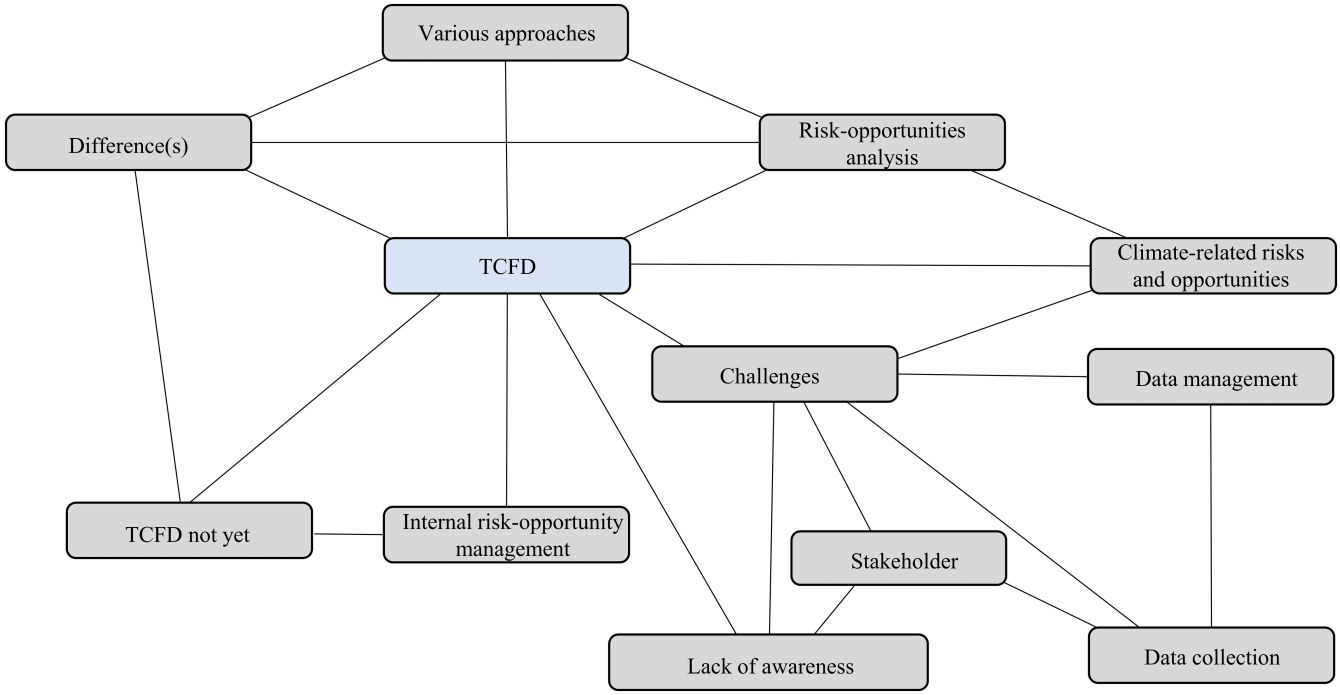

FIGURE 1 | Associations with TCFD (authors' own illustration; terms are associated with the central term at least four times).

As illustrated particularly on the right side of Figure 1, respondents tend to associate the TCFD framework with a range of implementation challenges. These include difficulties in identifying and analyzing risks and opportunities, as well as complexities related to data collection and management. In addition, stakeholder-related issues, particularly the lack of stakeholder awareness and engagement, are frequently mentioned. These associations reflect the multifaceted demands of applying the TCFD in practice and highlight key barriers perceived by companies in operationalizing climate risk reporting.

In the following sections, we therefore focus on the key challenges facing climate-related reporting by taking a closer look at the climate-related risks and opportunities (Figure 2), the stakeholders (Figure 3), the data and data management (Figure 4), and the sustainability management structures (Figure 5). These figures represent the network graphs of the respective topics, reveal the associations between the topics and related terms, and thus provide deeper insights into the complexity of the associated challenges. This graphic analysis is reinforced with additional quotes from the interviews.

This detailed analysis begins with an exploration of how respondents perceive and associate climate-related risks and opportunities (CRO), challenges already illustrated in Figure 1. Figure 2 offers a more nuanced view of these associations. By analyzing the key terms and linkages associated with risks and opportunities, the study uncovers how climate issues are interpreted within the organizational context, what dimensions are considered most relevant in practice, and which specific challenges arise for companies as a result.

The respondents associate climate-related risks (lower part of Figure 2; black frame) primarily with physical risks, such as flooding, heavy rainfall, and general weather-related disruptions that have the potential to impair supply chains, as one respondent states:

> "[...] the [factory] is, of course, also at risk from heavy rain, storms, i.e., weather conditions that are becoming increasingly frequent, or forest fires, which are also on the rise."
>
> (Interview VI)

These types of events are perceived as having a direct operational impact, particularly in terms of logistical interruptions and supply chain vulnerabilities. Additionally, rising temperatures and associated phenomena such as droughts and heatwaves are acknowledged by the interviewees, as reflected in the following statement:

> "In terms of concrete or tangible issues currently or in the future, these include disruptions to supply chains due to natural disasters or the need to expand air conditioning systems due to rising temperatures, even in Europe."
>
> (Interview I)

However, chronic physical risks such as rising temperatures and prolonged droughts are typically not perceived as causing immediate or abrupt supply chain disruptions. Instead, they are framed as more gradual environmental pressures that unfold over time and require longer-term adaptation measures rather than short-term operational responses. This distinction is illustrated by the following statement:

> "As you grow [as a company], you can also become more vulnerable to supply chain disruptions. You

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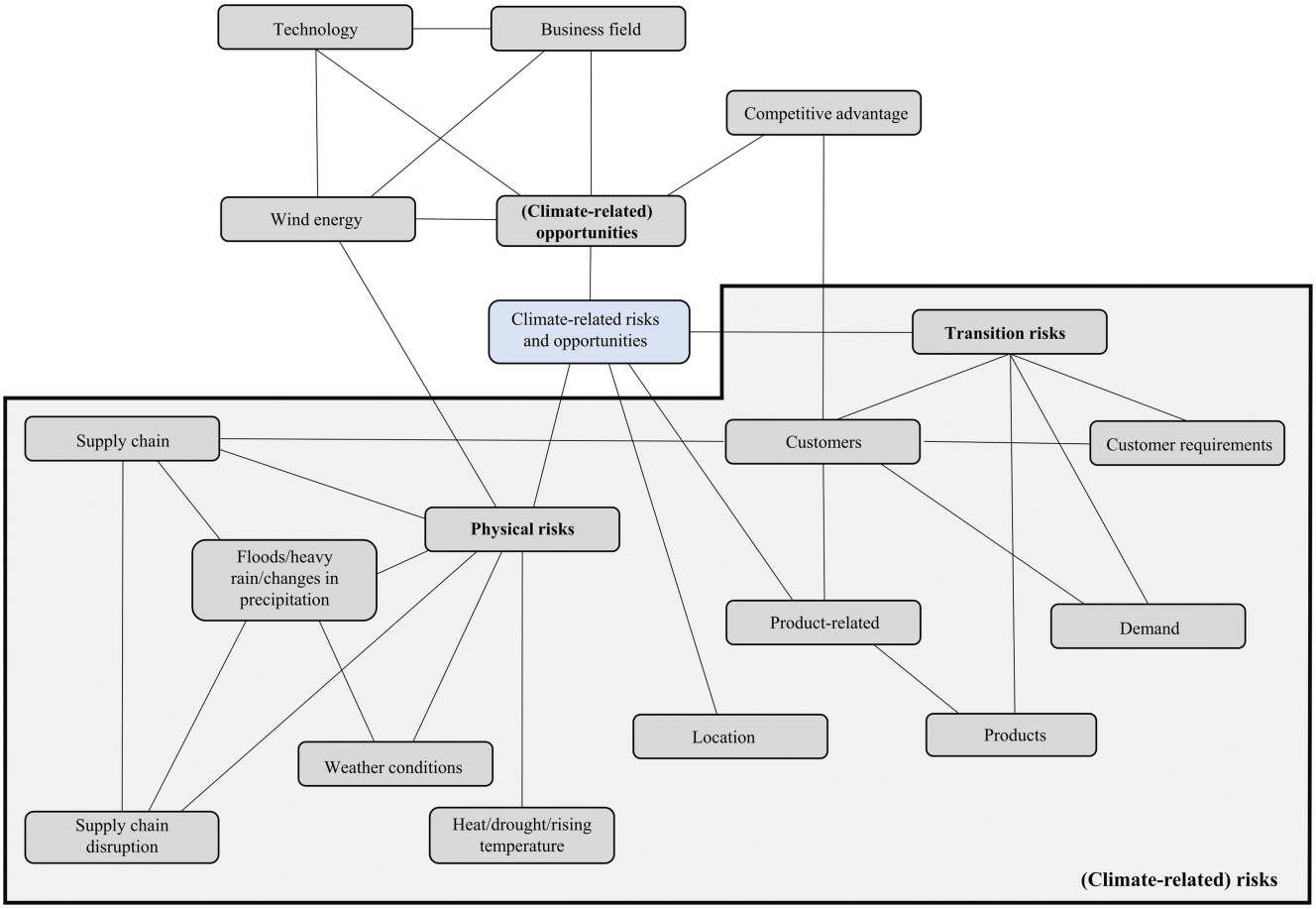

FIGURE 2 | Associations with climate-related risks and opportunities (CRO) (authors' own illustration; terms are associated with the central term at least three times, for the term "(Climate-related) opportunities" at least one time).

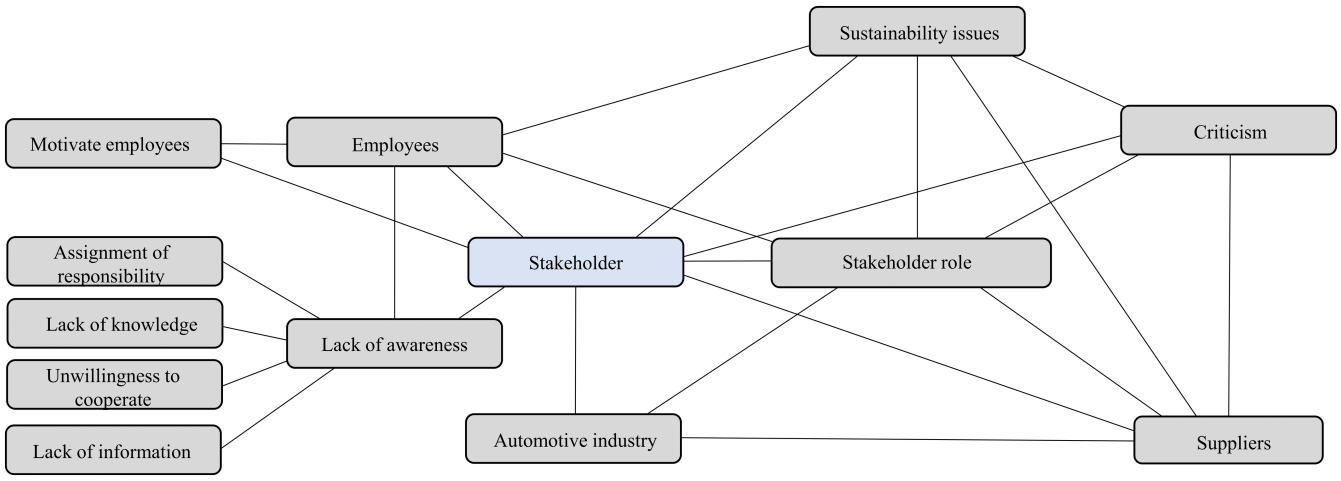

FIGURE 3 | Associations with stakeholders in the context of CRO (authors' own illustration; terms are associated with the central term at least three times).

> must secure the supply chain differently and with natural environmental risks like [rising] temperature, it doesn't all hit you at once."
>
> (Interview I)

In terms of transition risks, the experts most frequently reference customer-related factors, especially changing demand patterns and expectations for more climate-friendly products. However, this refers not only to the product itself, but also to information and data that the customer requires from a company (see Figure 4 for more information), as expressed in the following statement:

> "On the other hand, which is also a big issue that we [...] deal with, is ultimately the increased demand of customers, because I think that's probably a

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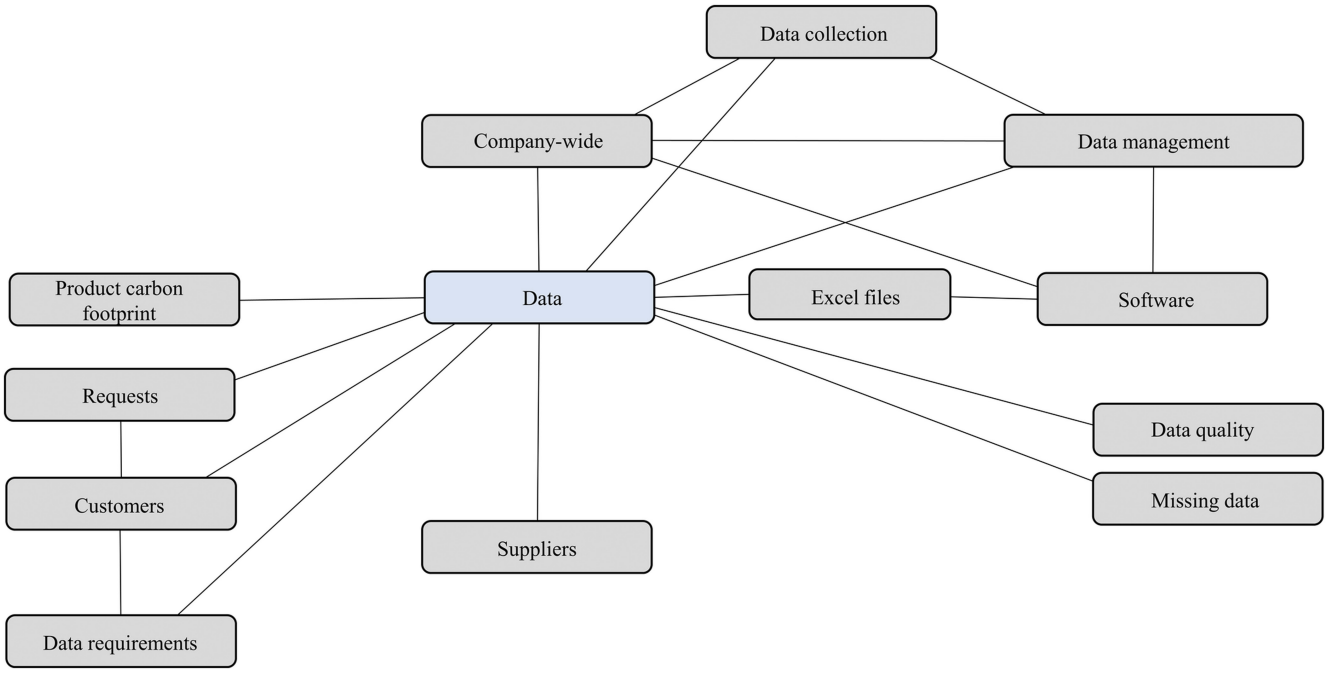

FIGURE 4 | Associations with data in the context of CRO (authors' own illustration; terms are associated with the central term at least three times).

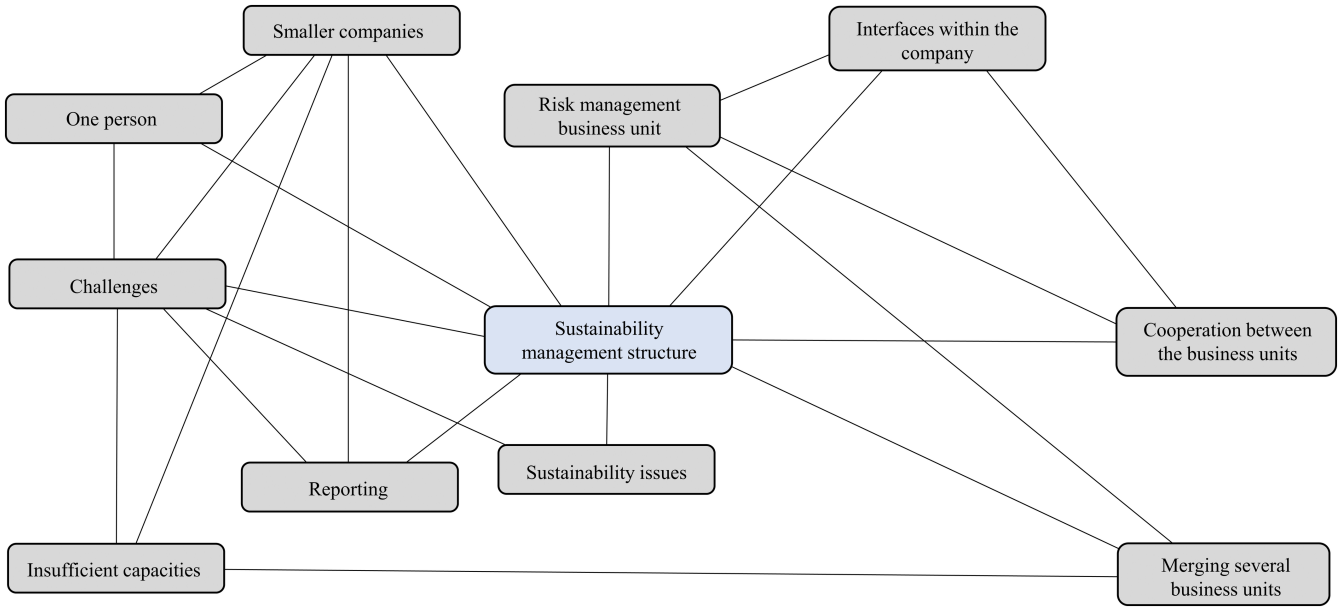

FIGURE 5 | Associations with sustainability management structure (authors' own illustration; terms are associated with the central term at least two times).

> general issue, it's not just related to our industry, but of course we're also aware that the maximum CO_2e footprint has to be reduced (...) or we have to deliver LCAs [Life Cycle Assessments], we're also climate-driven, because of course everyone wants to make sure that the CO_2e footprint is as small as possible."
>
> (Interview I)

These insights indicate that companies perceive shifts in consumer preferences and associated reputational or market risks as central aspects of the transition toward a low-carbon economy.

The upper part of Figure 2 illustrates that the growing customer demand for climate-friendly products is not only perceived as a risk but also as a strategic opportunity. Respondents emphasized that meeting this demand could generate competitive advantages, particularly for companies capable of aligning

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their offerings with sustainability expectations. In addition to market-based opportunities, technological innovations and the expansion of renewable energy sources are seen as key enablers of climate-related transformation. These developments are regarded as potential levers for business model innovation and long-term resilience. All in all, this reveals that customer requirements are both a risk and an opportunity, as one expert illustrates using the example of green steel:

> "If we don't meet those requirements – or talking about green steel – then of course that's a risk. So, for us, some of these issues are both an opportunity and a risk, depending on how well you can deal with them and whether you can use them in a positive way and somehow influence your own supply chain, because unfortunately green steel is not yet available very often or sufficiently and at the same time there is so much demand for it and I think these are definitely issues."
>
> (Interview I)

Nevertheless, the association network reveals a notable imbalance: experts tend to focus more strongly on climate-related risks than on opportunities. This asymmetry suggests that although companies are increasingly aware of the threats posed by climate change, the proactive exploration and strategic framing of climate-related opportunities remains underdeveloped in many organizations.

Certain foundational conditions must be met to effectively analyze and identify CRO, as a prerequisite for addressing them strategically. As already indicated in Figure 1, one of the key challenges lies in the stakeholder context. Several respondents highlighted obstacles related to stakeholder awareness, expectations, and engagement, which influence both internal prioritization and external communication of climate-related issues. A more detailed examination of stakeholder-related associations is needed to further explore these challenges. Figure 3 shows the respondents' associations with stakeholders.

The association network in Figure 3 underscores the pivotal role that stakeholders play in the context of CRO. Notably, suppliers, particularly those in the automotive sector, emerged as a critical stakeholder group. As they often possess inadequate climate-related information, they are frequently mentioned in connection with challenges related to climate risk analysis. In an interview, the situation is described as follows:

> "[...] On the one hand, there is a lot of pressure from customers. On the other hand, there are regulations, which now naturally affect large companies, and there are examples such as (brand name A) or (brand name B) passing on the pressure 1:1 to their suppliers. There are tenders, and depending on the scores you receive, for example from Ecovadis or [...], which is a specific tool for supplier evaluation in the automotive industry, the awarding rights are then clearly regulated. If suppliers do not adapt, there will probably be long-term consequences."
>
> (Interview VIII)

One key issue raised by respondents is that business partners increasingly require from one another climate-relevant data and strategic insights about sustainable issues. This reciprocal demand reflects the growing importance of climate transparency across the value chain. Criticism from suppliers often stems from the pressure to provide or obtain reliable information for conducting their own risk assessments and formulating climate strategies. This highlights systemic interdependence, where a company's ability to conduct robust climate analyses is partially contingent on the data and commitment of its upstream and downstream partners (for further explanations, see Figure 4).

On the left side of Figure 3, another key challenge becomes evident. The experts interviewed frequently identify employees as critical internal stakeholders in the context of CRO. Their role is seen as essential not only for implementing climate strategies, but also for anchoring these issues strategically within the organization. A recurring association in the interviews is the perceived lack of awareness and engagement among employees, which is viewed as a major barrier to effective climate action: the responsibility for the topic is often placed with sustainability management. For example, one expert notes:

> "I think a lot of people [lack of awareness] and I mean both levels, both our colleagues from the different departments and also from management, they are not really aware of this [climate risks and opportunities]. I interpret it more along the lines of: Sustainability [as a department] knows about it and they are already taking care of the issue."
>
> (Interview V)

Experts emphasized that motivated and informed employees are crucial to driving change, yet many organizations face internal resistance or indifference toward climate topics. This lack of awareness is associated with several underlying issues: the absence of clearly assigned responsibilities, limited knowledge about climate risks and their implications on the business model, insufficient access to relevant information and a lack of willingness to collaborate across departments. As a result, those directly responsible for climate-related initiatives often feel that the topic is not given adequate priority or strategic weight within their organizations. This perceived marginalization of climate concerns highlights the need for internal cultural change and stronger cross-functional integration and requires a great effort of explanation on the part of sustainability management (see also Figure 5), as this expert, for example, describes:

> "So, you are dependent on the individual departments to get the data, the input and accordingly you simply have to explain why you need the whole thing, where does the whole picture

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> fit in? What are they receiving when they devote 2-3 hours a week to the topic?"
>
> (Interview VIII).

In addition to stakeholders, data management emerges as a central challenge in the context of CRO, as illustrated in Figure 4. Respondents frequently associate data with practical implementation barriers, particularly in relation to its availability, quality, and relevance.

One key insight from the interviews is that data is not only required by the companies themselves but is also actively requested by external stakeholders, especially suppliers and customers who have their own information needs and reporting obligations. These mutual expectations create a complex web of data exchange requirements along the value chain, further intensifying the pressure on companies to generate, validate, and manage climate-relevant data efficiently. This is shown in the following description of a respondent:

> "You can see this in the constant requests for platforms such as CDP or Excel files or homemade platforms, such as those used by [brand name], for example. Then the suppliers – in this case, us – have to enter some data there. And the same applies to us, so we also need data somehow and are naturally striving for better data quality."
>
> (Interview I)

Furthermore, the analysis reveals that climate-related data is needed not only for broader corporate reporting obligations (e.g., under CSRD), but also for more specific purposes such as calculating the overall CO_2e emissions of a product, the so-called *product carbon footprint* (PCF). This is particularly evident on the left side of the association network, where PCF is closely linked to data-related challenges as one respondent states: "We will make [the suppliers] aware once again of the topic of climate and the collection of emissions data, after all we need a PCF, which is also part of the chain." (Interview VII) The interviews indicate that many organizations still lack standardized systems and processes to collect and aggregate reliable emissions data at the product level, an issue that affects both internal climate strategies and external reporting credibility.

Another major challenge identified by the interviewees concerns not only the availability of data but also its quality and completeness. Respondents frequently pointed to gaps in data coverage and inconsistent data accuracy as limiting factors for meaningful CRO analysis. One expert states:

> "We have always been at the disclosure requirement level, then at the data point level, and compare that, for example, with the points or with the information we already have in the company and information that we do not yet collect or that we do not yet collect with the required data quality."
>
> (Interview IV)

In addition to these content-related issues, data management itself is perceived as a significant organizational barrier. This challenge is often framed as a company-wide problem, particularly in relation to the coordination and collection of data across different departments and business units. The process is described as fragmented and inefficient, with insufficient integration of sustainability-relevant information into existing systems. Experts are very aware of the relevance of the topic, for example:

> "In any case, it is advisable to move away from Excel files and use software to give the figures a certain degree of credibility. In particular, the auditors who then check the report say: 'If you have good software that structures the data collection better and more systematically, then the figures are also more verifiable."
>
> (Interview VII)

A recurring theme is the lack of appropriate software infrastructure to support systematic data collection and processing. In many cases, companies still rely heavily on Excel files, a practice seen as a temporary workaround rather than a sustainable solution: "That's another key word, we work a lot with Excel files, a lot of documents going back and forth and that's just not feasible in the long-term with the current requirements." (Interview III). Experts emphasized that this approach is error-prone, time-consuming, and difficult to scale, especially in light of increasing reporting demands and growing expectations for data-driven decision-making.

It becomes clear that from the expert perspective, an effective assessment and management of CRO relies heavily on three key factors: subject-matter expertise (Figure 2), stakeholder engagement (Figure 3), and robust data management (Figure 4). However, as the association network in Figure 5 illustrates, these tasks must be embedded within a well-functioning organizational sustainability structure to be operationalized effectively.

In the upper right section of Figure 5, the association network shows that sustainability teams often need to collaborate closely with risk management departments, especially in the context of climate-related disclosures. This reflects a shared understanding among respondents that climate issues cannot be addressed in isolation; rather, they require cross-functional coordination, particularly where risk assessment is concerned.

Whereas this part of Figure 5 highlights an emerging conceptual alignment within organizations, the remainder of the network points to significant implementation challenges. On the left side of Figure 5, for example, it becomes evident that smaller companies, particularly those not listed on stock exchanges, often have only one person responsible for sustainability. This limited resourcing poses a substantial barrier, especially when navigating complex and resource-intensive reporting requirements such as those mandated by the CSRD: "Of course, it [managing CRO] is a challenge to implement directly. Because it's just not manageable for one person or two or three people." (Interview VI). Another critical insight emerges from the lower right side of the network: sustainability officers

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in these organizations are expected to manage inputs from multiple departments, coordinate across business units and synthesize information from a wide range of internal sources. However, given their frequently limited capacity and institutional support, these individuals face significant difficulties in fulfilling these roles effectively. This reveals a structural gap that hampers not only compliance but also the integration of sustainability into strategic decision-making processes.

5 | Discussion and Conclusion

The empirical findings of this study offer valuable insights into the current state of corporate practices regarding climate-related risk and opportunity analysis, under the evolving regulatory landscape shaped by the TCFD framework and the CSRD. The results confirm the central role that the TCFD continues to play as a reference point for climate-related disclosure both as a regulatory foundation and as a conceptual framework for structuring corporate responses to climate risks. At the same time, the analysis reveals significant heterogeneity in how companies approach the topic, suggesting that the institutionalization of climate risk reporting is still at an early and uneven stage.

One of the most prominent findings is the imbalance in corporate perception between climate-related risks and opportunities. Although physical and transition risks, especially those linked to supply chain disruptions and changing customer demands, are widely recognized, opportunities such as product innovation, efficiency gains or competitive positioning are addressed with considerably less strategic emphasis. This risk-dominant framing is consistent with previous research (e.g., Elijido-Ten and Clarkson 2019) and may reflect a risk-averse mindset that prioritizes compliance over innovation.

The findings point to a set of interrelated organizational and institutional challenges that shape how climate-related reporting frameworks are interpreted, operationalized and embedded in corporate practice. Specifically, this set comprises five interrelated dimensions: (1) stakeholder dynamics; (2) implementation maturity and institutionalization; (3) data availability, quality, and integration; and (4) organizational governance and structural embedding:

1. Stakeholders are both sources of pressure and partners in implementation, particularly customers who increasingly request climate-related data or suppliers who struggle in providing adequate sustainability data. This highlights the systemic interdependence within the value chain, as a company's ability to perform meaningful climate analyses partly relies on the data quality and commitment of its upstream and downstream partners. It reinforces the need for collaborative efforts beyond organizational boundaries. Internally, however, low awareness among employees, unclear role assignments, and limited cross-functional collaboration impede the institutional anchoring of climate strategies. These findings underscore the need for internal capacity-building and cultural change to align organizational processes with external expectations.
2. In addition to these overarching conclusions, the findings do not support a clear-cut differentiation between companies, with and without prior engagement in TCFD-aligned reporting, in terms of systematically distinct levels of maturity in climate-related risk and opportunity analysis. Rather, the interviews indicate that across organizations, practices related to the identification, assessment and strategic integration of climate-related risks and opportunities remain largely fragmented and insufficiently institutionalized. Whereas individual respondents referred to emerging governance arrangements or initial methodological distinctions between physical and transition risks, such practices appear to be selectively developed and only weakly embedded in organizational routines. This pattern of limited methodological consolidation and experiential learning is consistent with prior empirical research documenting substantial heterogeneity and gradual evolution in climate-related disclosure practices across firms (Ding et al. 2023; Jeanne et al. 2023). Importantly, existing studies also suggest that formal engagement with frameworks such as the TCFD does not necessarily translate into fully developed internal capabilities but often coincides with a combination of substantive elements and symbolic or compliance-oriented practices (Bingler et al. 2022). Against this backdrop, the findings of the present study suggest that the central challenge lies less in categorical differences between reporters and non-reporters, and more in a generalized lack of accumulated practical experience, organizational learning and routines required to operationalize climate-related risk and opportunity analysis in a systematic, forward-looking and strategically meaningful manner.
3. In terms of data, the study highlights persistent deficits in sustainability-related data availability, quality and integration, especially in smaller firms that rely on already available tools like Excel. These technical and systemic limitations hinder the development of robust, forward-looking analyses, such as scenario planning or product-level carbon accounting. Importantly, data-related challenges are not isolated but deeply embedded in broader organizational structures, as seen in the overburdening of individual sustainability managers and the lack of coordination between sustainability and risk departments.
4. From a structural perspective, the results suggest that climate risk analysis must be embedded in a broader understanding of corporate governance, where climate-related issues are not treated as peripheral concerns but integrated into core business strategy. The observed need for collaboration between sustainability and risk management teams, as well as the struggles of under-resourced sustainability functions, particularly in smaller companies, where the sustainability team often consists of a single individual, point to missing institutional coherence, which is critical for effective implementation of the CSRD and similar frameworks.

These insights also enhance the academic understanding of why climate-related disclosure quality varies substantially across firms. Though prior research has documented considerable heterogeneity in TCFD-aligned reporting and identified structural

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gaps in data availability, governance and methodological readiness, the internal dynamics behind these gaps remain underexplored. By providing qualitative, practice-based evidence from organizations at different stages of TCFD maturity, our study extends the existing literature by illustrating how internal capabilities, cross-functional coordination, and institutional pressures shape firms' ability to operationalize climate-related risks and opportunities in a meaningful way. This contributes to closing a conceptual gap in the literature, which has so far been dominated by disclosure-based or quantitative analyses (Tumewang et al. 2025).

The analysis also points to several practical implications for management and policy. Strengthening these organizational foundations, therefore, represents a critical leverage point for managers seeking to enhance the resilience, robustness and accountability of climate-related decision-making. In light of the empirical findings, this primarily entails developing defined governance structures, clarifying responsibilities beyond isolated sustainability functions and establishing routines that enable the systematic integration of climate-related risks and opportunities into existing risk management and strategic planning processes. Without such institutional anchoring, climate-related analyses remain fragmented and largely decoupled from managerial decision-making, irrespective of formal reporting requirements. For regulators, the pronounced variation and generally low maturity of organizational practices observed in this study underscore that regulatory mandates alone are insufficient to ensure decision-relevant and comparable climate-related information. Many organizations continue to face structural and methodological barriers—including methodological uncertainty, limited data availability, and implementation challenges—that constrain the transparency and comparability of sustainability-related disclosures. Accordingly, there is a critical need for targeted guidance and capacity-building measures that address these obstacles. In particular, harmonizing reporting requirements and providing standardized reference frameworks for scenario analysis, risk quantification, and data management can reduce interpretative ambiguity, lower the implementation burden for firms with limited internal resources, and support the production of more credible, decision-relevant climate information.

The findings of the study also have broader implications for the concept of climate resilience, which increasingly functions as a central evaluative criterion for both regulators and investors. The study shows that many organizations are still in the early stages of developing the internal structures and processes necessary to systematically assess, communicate and act upon climate-related risks. Climate resilience, understood as the ability to anticipate, absorb, and adapt to climate-related disruptions while maintaining operational and financial stability (Huiskamp et al. 2022; IPCC 2007), is contingent upon precisely those factors found to be lacking: strategic integration, cross-functional cooperation, stakeholder responsiveness, and robust data systems. Addressing these gaps is therefore not just a matter of compliance, but a prerequisite for building long-term organizational resilience in the face of increasing climate risks.

Against this backdrop, emerging digital and AI-based tools may play a supportive role in addressing some of the structural and methodological deficits identified in this study. By facilitating the aggregation, validation, and interpretation of heterogeneous climate-related data, as well as supporting scenario development and pattern recognition, such tools have the potential to alleviate capacity constraints and enhance analytical consistency. However, their effectiveness is contingent upon robust data governance, clear accountability structures, and strategic embedding. Absent these organizational preconditions, digital solutions risk reinforcing existing fragmentation rather than contributing to substantive improvements in climate-related decision-making (Yin, Yin, and Wen 2025).

Overall, the findings suggest that advancing climate-related risk and opportunity analysis requires a coordinated interplay between regulatory guidance, organizational capability development, and enabling digital infrastructures. This perspective extends existing debates on institutional pressures in sustainability reporting by highlighting that transparency and comparability are not solely regulatory outcomes but emergent properties of organizational learning, governance design, and methodological structures.

Although this study contributes important empirical insights to a relatively underexplored area of sustainability research, it is subject to certain limitations. The qualitative design and limited sample size, focused on expert perspectives within a non-representative set of companies, restrict the generalizability of the findings. The results are, therefore, contextual rather than representative, offering a depth of understanding that should be complemented by future quantitative or longitudinal studies to track changes in corporate practices over time. Despite the use of the rule-based *GABEK* method and the associated advantages, subjectivity and possible researcher bias cannot be completely ruled out in the analysis, particularly in the interpretation of the results. This limitation was addressed through continuous reflection processes among the researchers and through team discussions. Furthermore, the study focuses on perceptions and self-reported practices, which may not always reflect actual implementation. There is, thus, a need for comparative, cross-sectoral analyses that combine qualitative insights with reporting data to triangulate findings and identify industry-specific best practices. Finally, further research is warranted to explore mechanisms that enhance climate resilience, particularly in relation to internal governance, change management and digital infrastructure. Such research should also examine the evolving role of sustainability professionals and how organizational design influences the success of climate risk reporting.

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Endnotes

[1] Although the European Commission's Omnibus package introduces partial reliefs and implementation deferrals for sustainability reporting, these changes primarily affect the scope and timing of CSRD obligations rather than the underlying logic of climate-related risk and opportunity assessment (Council of the European Union 2026). The empirical material of this study was collected prior to the Omnibus proposal and therefore reflects firms' perceptions under the original CSRD design. This temporal context is explicitly considered in the discussion section.

[2] Notwithstanding recent regulatory relief and scope adjustments under the EU's Omnibus package, many companies remain, *de facto*, exposed to climate-related reporting and data provision requirements. First, firms operating in global value chains are increasingly required to provide climate-related information to business partners located in jurisdictions with mandatory TCFD- or ISSB-aligned disclosure regimes (e.g., the United Kingdom, New Zealand or Japan), which frequently entails upstream data requests to suppliers. Second, financial market actors—including institutional investors, lenders and insurers—continue to place strong emphasis on climate-related risk information for capital allocation, risk pricing, and stewardship purposes. As a result, companies face persistent market-driven and transnational pressures to assess and disclose climate-related risks and opportunities, even where formal domestic reporting obligations have been reduced or deferred (Gebhardt et al. 2024).

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