THE INTEGRATION OF CLIMATE-RELATED RISKS INTO FINANCIAL RISK MANAGEMENT WITHIN THE VIETNAMESE STEEL ENTERPRISES: CHALLENGES AND IMPLEMENTATION STRATEGIES

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Abstract: ***As climate change has become a material risk with significant implications for corporate financial performance, the integration of climate-related risks into financial risk management frameworks has emerged as an essential and increasingly indispensable practice for enterprises. This research identifies the key challenges associated with this integration process within the Vietnamese steel companies. Utilizing a qualitative research methodology based on survey data collected from the enterprises affiliated with the Vietnam Steel Association, the paper identifies three main categories of challenges: (1) institutional barriers and limitations in implementation guidance; (2) data constraints and the complexity of translating climate-related risks into quantifiable financial metrics; and (3) limitations in organizational resources and managerial mindsets. Based on these findings, the study proposes a set of macro- and micro-level solutions to promote the integration of climate risks into financial management practices within steel enterprises to enhance resilience and create sustainable competitive advantages in the green economy era.***

• Keywords: *financial risk management, climate-related risks, sustainable finance.*

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1. Introduction

Climate change is increasingly recognized as a material risk that directly affects corporate value through rising operational costs, supply chain disruptions, changes in asset valuation, and constraints on access to capital (Dow & Shi, 2025). Therefore, incorporating climate-related risks into financial risk management frameworks is a prerequisite for enhancing organizational resilience and long term sustainability. To support enterprises in identifying an

d managing climate-related risks, various management frameworks and reporting standards have been established, notably the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) serve as a prominent example (Jona & Soderstrom, 2022). However, the practical integration of climate-related risks into financial risk management frameworks remains difficult due to data limitations, insufficient analytical capabilities, and the complexity of climate projection models (Singh & Goyal, 2023; Zhao et al., 2025). As a result, the integration is still at an early stage of development, with many enterprises focusing primarily on reactive adaptation measures after risks materialize, rather than proactively incorporating climate risk scenarios into their business strategies and risk management systems (Leitold et al., 2021).

In Vietnam, the steel industry is characterized by high energy consumption and significant greenhouse gas emissions. Steel enterprises are currently facing dual pressures from domestic and international fronts. Domestically, Vietnam has committed to achieving Net Zero emissions by 2050. Internationally, the industry must navigate barriers such as the Carbon Border Adjustment Mechanism (CBAM) of the European Union. These pressures are likely to increase compliance costs, as well as capital expenditures on green technologies and the adoption of internal carbon pricing mechanisms. Furthermore, the Vietnamese steel enterprises are highly dependent on imported raw materials, while

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the coastal location of many production facilities exposes them to heightened risks of supply chain disruptions and infrastructure damage caused by extreme weather events. Such climate-related risks can readily translate into financial risks, leading to increased costs, weakened liquidity, and deteriorating business performance. Given the high level of exposure to climate-related risks, integrating these risks into financial risk management frameworks is essential for steel enterprises. This research clarifies the challenges, thereby enabling firms to develop appropriate solutions to promote the integration of climate-related risks into their financial strategies, ensuring sustainable and efficient operations.

2. Theoretical Framework

Modern theoretical frameworks categorize climate-related risks into two primary components: physical risks and transition risks. Physical risks arise from the direct impacts of climate change, such as natural disasters, extreme weather events, global warming, and rising sea levels. These factors can disrupt production, supply chains, and broader economic activities. Conversely, transition risks stem from structural changes associated with the move toward a low carbon economy. These include regulatory shifts, green technological breakthroughs, and evolving preferences among consumers and investors. While both risk types are significant, they differ fundamentally in their transmission mechanisms (Zhou et al., 2023). Physical risks often lead to sudden shocks and immediate financial losses. In contrast, transition risks tend to unfold gradually, shaping long term investment strategies and asset revaluations.

Climate-related risks exert a transformative influence on financial risks. Specifically, physical risks directly affect cash flow expectations and corporate value by increasing operating costs, damaging fixed assets, and disrupting global supply chains (Dow & Shi, 2025; Leitold et al., 2021). Transition risks increase compliance costs and investments in green transformations (Dow & Shi, 2025; Massey, 2022). Simultaneously, they influence capital raising costs and corporate investment behavior (Di Febo, 2025). Stringent carbon emission regulations may reduce asset values in energy intensive industries. Furthermore, such regulations create credit and liquidity risks for enterprises within these sectors (Thai et al., 2024; Vu Hiep et al., 2024).

Regarding modeling and measurement, the transition from traditional financial risk management to adaptive risk management is an essential requirement in the face of climate uncertainty. Traditional methods often rely on historical data to forecast the future. However, this approach reveals significant limitations due to the non-linear and unpredictable nature of climate phenomena (Maksymova et al., 2024; Wagner, 2026). Consequently, modern frameworks, such as the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), help enterprises integrate climate-related risk factors into core financial decisions. The TCFD framework is based on the philosophy that climate-related risks should be identified and reported with the same rigor as traditional financial risks to ensure transparency for investors and stakeholders.

The TCFD framework is structured around four core pillars: governance, strategy, risk management, and metric & targets. The governance pillar emphasizes on establishing the oversight responsibilities of the board of directors and the executive role of management in addressing climate-related issues. Organizations are therefore required to clearly describe the mechanisms used by the board to review climate-related risks and opportunities when approving strategies, action plans, and annual budgets. The strategy pillar requires enterprises to assess and disclose the actual and potential impacts of climate-related risks and opportunities on their business models, strategic orientation, and financial planning. A key innovation within this pillar is the requirement for scenario analysis regarding climate variables. The third pillar, risk management, focuses on the processes used to identify, assess, and manage climate-related risks. The TCFD underscores that such risks should not be addressed in isolation; rather, they must be fully integrated into the organization's existing enterprise risk management (ERM) framework. This includes determining the materiality of climate risks and establishing how they are prioritized relative to other categories of risk. Finally, The establishment of specific, measurable, and time-bound targets enables stakeholders to monitor progress and assess the organization's capacity to generate sustainable value within a low-carbon economy.

3. Research Methodology

To clarify the existing challenges and propose solutions for integrating climate-related risks, this

study utilizes a qualitative approach supported by an empirical survey.

The literature review and theoretical framework analysis are conducted using data gathered from reputable academic databases, specifically Scopus and Web of Science. International benchmarks, including the TCFD framework and IFRS S2 standards, serve as the primary reference points alongside empirical studies on climate finance.

The empirical portion of the research involves a survey targeting middle and senior management within the financial and executive divisions of steel enterprises belonging to the Vietnam Steel Association. Data collection and processing took place from September 2025 to November 2025. A total of 126 valid responses were obtained, providing a representative sample of the diverse sectors within the steel industry. This sample includes construction steel production (46%), steel pipe production (5.5%), galvanized and color-coated steel (9.5%), and trading or other related sectors (38.9%). The survey instrument was developed by adapting established international studies and was further refined through expert consultations to ensure alignment with the specific management landscape in Vietnam.

Finally, through synthesis and logical reasoning, the study proposes implementation strategies at both the macro level regarding policy planning and the micro level concerning corporate operations. These strategies aim to facilitate the integration of climate risks into enterprise risk management frameworks.

4. Research Results

Based on the empirical survey findings from Vietnamese steel enterprises, the challenges associated with integrating climate-related risks into financial risk management can be categorized into three areas: (1) institutional barriers and limitations in implementation guidance; (2) data constraints and the complexity of translating climate-related risks into quantifiable financial metrics; and (3) limitations in organizational resources and managerial mindsets.

Institutional barriers and limitations in implementation guidance

The lack of a synchronized institutional framework and detailed implementation guidelines creates significant obstacles for steel enterprises. Survey results indicate that firms perceive institutional misalignment as a major barrier, yielding a mean score of 4.2 out of 5. This finding aligns with research by Do and Nguyen (2025), which observes that while Vietnam has made progress in developing sustainable policies, a substantial gap remains between macro-level directives and micro-level implementation standards for businesses. Currently, Vietnam has not issued a formal and comprehensive green taxonomy. This deficiency prevents enterprises from objectively identifying and classifying green assets versus high risk brown assets. Consequently, inconsistency arises when determining materiality thresholds for assessing climate impacts on balance sheets (Dow & Shi, 2025; Vu Hiep et al., 2024). This specific issue was rated as a significant hurdle with a mean score of 4.3/5.

Regarding measurement standards, domestic regulations do not yet meet the rigorous requirements of international frameworks such as TCFD or IFRS S2. While many nations have mandated disclosures based on TCFD recommendations to standardize climate risk reporting, adoption in Vietnam remains largely voluntary. This results in inconsistent implementation across the industry (Jona & Soderstrom, 2022). Steel enterprises reported notable difficulty in applying these international standards to their risk management processes, with an assessment score of 4.1/5.

In terms of disclosure, although Circular 96/2020/TT-BTC provides guidance for listed companies to report environmental and social impacts, these requirements are primarily qualitative. They lack mandates for climate scenario analysis or the quantification of Scope 3 emissions (Thai et al., 2024). This limitation received a score of 4.0/5 from the surveyed enterprises. The absence of standardized methodologies and technical parameters for the Vietnamese market leaves companies without a basis to measure potential losses from transition risks, such as carbon taxes or technology compliance costs (Maksymova et al., 2024; Wagner, 2026). This creates a cycle of information asymmetry where enterprises are uncertain about correct measurement techniques and financial institutions lack reliable data to assess environmental risks for green financing (Vu Hiep et al., 2024).

Furthermore, the monitoring mechanism for climate risk disclosure in Vietnam is voluntary and lacks strong sanctions to promote financial transparency. Empirical studies by Dinh and colleagues (2024) indicate that although climate risks negatively impact financial performance, voluntary

disclosure levels remain low and lack comparability across sectors. Steel enterprises rated the lack of strong monitoring and sanctions at 4.1 out of 5. Legal framework limitations increase compliance costs for firms pursuing green transitions and also introduce the risk of greenwashing. Disclosures often focus on corporate social responsibility efforts rather than reflecting substantive financial risks (Do & Nguyen, 2025; Massey, 2022). Concerns regarding the risk of greenwashing were identified as a significant challenge with an average score of 3.9/5.

Table 1. Survey results on institutional and implementation barriers

No.	Survey Question	Mean Likert Score
1.1	The institutional framework for integrating climate risks into risk management in Vietnam is unsynchronized, making implementation difficult.	4.2
1.2	The absence of a formal green taxonomy complicates the identification of green assets and high risk assets.	4.3
1.3	Current regulations only require qualitative environmental reporting and omit climate scenario analysis or Scope 3 quantification.	4.0
1.4	Enterprises struggle to apply international standards such as TCFD and IFRS S2 in risk management.	4.1
1.5	Weak monitoring mechanisms and a lack of sanctions result in low transparency and a lack of comparability in climate risk disclosures.	4.1
1.6	Enterprises fear the risk of greenwashing when disclosure requirements are unclear and fail to focus on substantive financial risks.	3.9

Source: Survey of enterprises under the Vietnam Steel Association

Second, data constraints and the complexity of translating climate-related risks into quantifiable financial metrics

The scarcity of climate data constitutes a major impediment to the integration of climate-related risks into financial risk management. Climate-related risks exhibit non-linear characteristics that are difficult to forecast using conventional statistical methods (Maksymova et al., 2024). Steel enterprises expressed a high level of agreement, rated at 4.5/5, regarding the difficulty of determining the probability of such extreme events. Furthermore, the reliance on historical data to predict anomalous climate shocks presents significant obstacles, receiving a score of 4.3/5. These constraints hinder the prediction of Black Swan climate events. Consequently, enterprises suffer from strategic blindness when allocating capital for adaptation measures (Dow & Shi, 2025).

Moreover, climate risks are highly localized, making them difficult to project based solely on global climate models. Enterprises often struggle to access relevant information at the corporate level. For instance, flooding at an industrial park in Ho Chi Minh City depends on a combination of tidal patterns, land subsidence, and local drainage systems. Global forecasting models frequently overlook these specific factors (Leitold et al., 2021). The lack of high-resolution localized data prevents enterprises from conducting accurate scenario analyses, which leads to biased assessments of asset loss. This challenge was rated at 4.1/5 by steel industry participants.

Managing climate-related risks requires long-term forecasting capabilities, the use of complex climate models, and the integration of environmental data with corporate financial records. In practice, many enterprises lack suitable analytical tools to convert climate information into financial risk indicators for decision-making (Singh & Goyal, 2023). The shortage of empirical datasets linking historical climate events to direct financial damages, such as revenue decline, increased insurance premiums, or asset degradation, complicates the conversion of climate info into financial data (Dinh et al., 2024; Thai et al., 2024). This difficulty is particularly evident in the steel sector, with a score of 4.4 out of 5. This deficiency prevents Chief Financial Officers from developing risk response functions to implement internal carbon pricing or calculate the risk-adjusted cost of capital (Wagner, 2026). Climate databases for financial risk analysis remain underdeveloped. As a result, enterprises find it difficult to apply advanced tools such as scenario analysis or climate stress testing. Consequently, climate risks are often restricted to qualitative descriptions in sustainability reports rather than being quantitatively integrated into financial risk management systems.

Table 2. Survey results regarding data limitations and the quantification of climate risks into financial metrics

No.	Survey Question	Mean Likert Score
2.1	Climate risks are non-linear and difficult to forecast using traditional statistics, making it hard to determine the probability of extreme events.	4.5
2.2	It is difficult to use historical data to predict anomalous climate phenomena.	4.3
2.3	There is a lack of high-resolution localized climate data required for accurate scenario analysis.	4.1
2.4	Enterprises lack the tools and methodologies to convert climate information into quantitative financial risk indicators.	4.4
2.5	There are no empirical datasets linking past climate events to specific financial losses such as revenue, insurance costs, or assets.	4.3
2.6	Enterprises struggle to develop risk response functions like internal carbon pricing or risk-adjusted cost of capital.	4.5

Source: Survey of enterprises under the Vietnam Steel Association

Third, limitations in organizational resources and managerial mindsets

Financial and human resource constraints

represent significant barriers to integrate climate-related risks into financial risk management. Establishing an effective climate risk management system requires substantial investment in personnel possessing interdisciplinary expertise across finance, risk management, and environmental science. Furthermore, the implementation of international risk measurement standards involves prohibitive costs. The combination of a specialized talent shortage and high expenses makes climate integration unattainable for many firms (Maksymova et al., 2024). Consequently, many enterprises adopt reactive risk strategies instead of proactive adaptation (Leitold et al., 2021). Survey results from the steel industry confirm these challenges, with human resource limitations and implementation costs receiving mean scores of 4.2 and 4.5 out of 5, respectively.

Parallel to resource burdens, a management mindset characterized by short-termism acts as a critical bottleneck for innovation. Boards of directors frequently prioritize immediate financial metrics and short-term profitability over climate risks which are often characterized by significant time lags and high uncertainty (Dow & Shi, 2025). As a result, measures to prevent or mitigate climate-related risks receive insufficient attention. A lack of structural integration where climate specialists are excluded from decision-making processes often results in climate risk being omitted from strategic risk portfolios. This omission leaves enterprises vulnerable to both physical and transition risks. These management mindset limitations were identified as major obstacles with high levels of agreement in the steel industry survey.

Table 3. Survey results regarding resource limitations and management mindset

No.	Survey Question	Mean Likert Score
3.1	Enterprises lack human resources with interdisciplinary knowledge in finance, risk management, and environmental science to operate climate risk systems.	4.2
3.2	The cost of implementing international-standard climate risk measurement systems exceeds corporate financial capacity.	4.5
3.3	Enterprises prioritize short-term profit targets over investing in long-term climate risk management.	4.4
3.4	Current climate change response strategies are primarily reactive and temporary rather than proactive and long-term.	4.0

In summary, the integration of climate-related risks into enterprise risk management in Vietnam faces multiple hurdles. These include an incomplete institutional framework, insufficient implementation guidelines, data and analytical limitations, and internal constraints regarding resources and management philosophy. These challenges not only delay the integration of climate factors into financial risk systems but also heighten corporate vulnerability to future climate shocks. This situation necessitates urgent solutions to facilitate climate risk integration. Such measures will enhance the resilience of the steel industry and the broader Vietnamese business sector as climate change impacts escalate.

5. Solutions for enhancing the integration of climate-related risks into the financial risk management of Vietnamese steel enterprises

To address systemic barriers in integrating climate-related risks into corporate financial risk management, a synchronized approach spanning macro and micro levels is required.

At the macro level, the primary task involves bridging the institutional gap by promptly issuing a National green taxonomy. This framework provides a fundamental tool for steel enterprises to distinguish between green assets and high risk brown assets. Consequently, firms can quantify the materiality of climate risks on their balance sheets. This taxonomy should be developed based on international standards such as TCFD and IFRS S2 while incorporating adjustments for the specific context of Vietnam. It must also reflect industry specific characteristics, including metallurgical technologies, energy efficiency, and emission thresholds.

Secondly, a mandatory roadmap for climate related financial disclosures should be established for listed companies and high emission industries like steel. Disclosures must be standardized across the four pillars of governance, strategy, risk management, and metrics and targets. Furthermore, reports should require climate scenario analysis and the quantification of Scope 3 emissions, which represent the primary emission source in the steel supply chain. Monitoring mechanisms and sanctions are necessary to ensure transparency and comparability while mitigating the risk of greenwashing.

Thirdly, to encourage proactive compliance, the government should implement supportive policies such as tax incentives and low interest green credit. Technical assistance for investments in cleaner production technologies and climate risk measurement systems is also essential. These policies should be designed with flexibility to

account for enterprise size, with particular emphasis on supporting small and medium enterprises that face the greatest pressure from compliance costs.

At the micro level, enterprises must transition from reactive response to proactive adaptation. Rather than viewing climate change as a component of corporate social responsibility triggered only by losses, management should perceive climate challenges as opportunities to restructure business models and gain competitive advantages. Given the capital intensive nature of the steel industry and its reliance on long lived fixed assets, embedding climate risk into financial management and long term strategy is a fundamental requirement. Enterprises should move beyond short term perspectives by establishing KPIs for climate resilience and treating climate risk as a formal component of the risk portfolio. Identifying and quantifying risks through carbon price fluctuation scenarios and energy costs will enable firms to adjust asset structures and cash flow plans effectively. This restructuring should involve the establishment of ESG committees to ensure oversight and the integration of climate factors into the corporate risk matrix with clearly defined materiality thresholds.

In addition, to overcome data and measurement limitations, enterprises should invest in internal data systems and utilize localized climate information. Priority should be given to developing the capacity to transform climate information into quantitative financial indicators. Relevant metrics include production disruption losses, risk adjusted insurance costs, internal carbon pricing, and the cost of capital reflecting transition risks. Adopting advanced tools such as artificial intelligence and machine learning for scenario analysis and climate stress testing will improve forecast accuracy, particularly for non linear extreme events.

Finally, enterprises should strengthen resources through cooperation and interdisciplinary capacity building. To manage the costs of implementing international standard systems, steel companies can form collaborative mechanisms to share data costs and consulting services. Participation in technical support programs from international financial institutions is also recommended. Concurrently, firms must focus on training personnel with expertise spanning finance, risk management, and climate science. Encouraging short term training programs and international certifications through industry associations and domestic educational institutions will provide a sustainable foundation for the new risk management system.

6. Conclusion

Climate change adaptation is no longer a matter of corporate social responsibility, it has become a critical requirement for organizational survival and a key indicator of core competitiveness in the new era. Although challenges such as the lack of reliable data, policy uncertainty, and resource constraints persist, the integration of climate-related risks into financial risk management represents an inevitable trajectory. This transition requires enterprises to move from reactive strategies to proactive management models.

Addressing the integration of climate-related risks into enterprise risk management requires a comprehensive and coordinated approach. For a regulatory perspective, the development of a comprehensive legal framework for climate-related disclosure, as well as the standardization of green criteria constitutes a necessary foundation. At the firm level, transforming managerial mindsets, governance structures, and risk management tools serves is a prerequisite for advancing climate risk governance. In the long term, the successful incorporation of climate factors into financial strategies will be the deciding factor in mitigating systemic losses. Furthermore, this process will enhance corporate resilience and secure sustainable development goals.

References:

Dinh, T. T. H., Nguyen, T. H., & Nguyen, T. P. (2024). Climate-related risks, firm performance and role of risk reserve funds: Empirical evidence in Vietnam. Journal of Sustainable Finance & Investment.

Do, C. V., & Nguyen, M. K. (2025). Legal and strategic drivers of sustainable business transformation: Case studies from Vietnam. International Journal of Law and Management.

Dow, S., & Shi, Y. (2025). Corporate finance under climate crisis: Sustainability Transitions in Theory and Practice. Springer.

Elisa Di Febo, (2025). Transition risk in climate change: A literature review. https://doi.org/10.3390/risks13040066.

Jona, J., & Soderstrom, N. (2022). Evolution of climate-related disclosure guidance and application of climate risk measurement in research. In Handbook of Accounting and Sustainability.

Leitold, R., Garschagen, M., Tran, V., & Diez, J. R. (2021). Flood risk reduction and climate change adaptation of manufacturing firms: Global knowledge gaps and lessons from Ho Chi Minh City. International Journal of Disaster Risk Reduction, 55, 102067.

Maksymova, I., Velhas, V., & Tokunova, A. (2024). Developing strategies for adapting business processes to climate change: Minimizing risks in the context of global climate challenges. Grassroots Journals.

Massey, M. (2022). Climate change enterprise risk management: A practical guide to reaching net-zero goals. Kogan Page.

Singh, S., & Goyal, M. K. (2023). Enhancing climate resilience in businesses: The role of artificial intelligence. Journal of Cleaner Production, 408, 137196. https://doi.org/10.1016/j.jclepro.2023.137196

Thai, H. M., Nguyen, G. T. H., & Nguyen, T. T. (2024). Impacts of climate change risks on financial performance of listed firms in agriculture industries in Vietnam. Journal of Agribusiness in Developing and Emerging Economies.

Vu Hiep, H., Ngo Quoc Dung, N., & Dang Tuan, N. (2024). The nexus between green banking initiatives and environmental performance: Examining the moderating effect of environmental risk management. Journal of Ecohumanism.

Zhao, Z., Tang, S., Huang, J., Yang, J., Ma, Z., & Fang, W. (2025). Firm-level climate risk assessment: Recent progress and future research agenda. Risk Sciences.