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Review

Barriers, Opportunities, and Best Practices for Corporate Climate Transition Plans: A Literature Review

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Abstract: Corporate climate transition is one of the greatest challenges and opportunities of the 21st century, shaping the future of business sustainability and aligning economic growth with global environmental goals. This article aims to identify the main barriers, opportunities, and best practices associated with the implementation of corporate climate transition plans. Based on a review of studies from leading databases—Scopus, Web of Science, ScienceDirect, and Google Scholar—the research categorizes barriers into economic, financial, political, regulatory, cultural, organizational, and technological dimensions. Opportunities are grouped into areas like sustainable finance, technological innovation, and resilience building. Best practices are organized into clusters, notably governance, energy efficiency, social equity, and just transition frameworks. In addition to advancing academic understanding, this study offers practical implications for key stakeholders. Financial institutions can use these findings to develop climate-aligned financial products tailored to corporate realities. Policymakers can improve regulatory frameworks to foster sustainable business practices and remove legislative barriers. Companies are empowered to refine their climate strategies, address operational constraints, and explore new sustainability-driven opportunities. By integrating scientific insights with real-world applicability, this review contributes to a more holistic understanding of corporate climate transition, bridging academic research with actionable pathways for businesses, financial actors, and public decision-makers.

Keywords: corporate climate transition; barriers; opportunities; best practices; successful examples; literature review; business sustainability

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1. Introduction

Corporate climate transition is one of the greatest challenges and opportunities of the 21st century. This determines the future of corporate sustainability and the ability of organizations to align economic growth with global environmental goals. For corporations, this transformation means not only an adjustment to the global environmental standards outlined in the 2015 Paris Agreement but also a transformational impetus that reconfigures market dynamics, regulatory frameworks, and consumer expectations. Despite the growing recognition of the imperative to address climate change, companies still face numerous obstacles in developing and implementing effective climate transition strategies [1,2].

In this context, the question is: what are the prevailing barriers, opportunities, and exemplary practices for the successful implementation of corporate climate transition strategies? The main purpose of this research is to outline, through a literature review, the main

barriers, opportunities, and exemplary practices relevant to the successful implementation of corporate climate transition strategies, highlighting good examples that can serve as a reference for corporations and policymakers.

Among the main barriers, financial impediments are the predominant challenges. The high initial costs associated with adopting green technologies and uncertainty about returns on investments generate reluctance on the part of companies [2,3]. This dynamic is intensified in developing countries, where credit shortages and misaligned financial incentives prevent the allocation of resources to sustainable initiatives [4,5]. In addition, the risk aversion demonstrated by shareholders and capital providers further compromises the efforts of companies, especially smaller ones, to transition to a low-carbon model [6].

Regulatory barriers also exacerbate the difficulties associated with corporate climate transitions. Political discrepancies, ambiguous patterns, and the absence of robust regulatory frameworks often generate volatility in markets and hinder decision-making processes [7,8]. For example, the mechanisms of the European Union Emissions Trading Scheme (EU ETS) face criticism due to temporal myopia and insufficient incentives to promote profound changes in corporate behavior [4]. These challenges highlight the need to identify integrated and coherent solutions that will allow us to overcome these barriers.

In the context of organizational frameworks, cultural and managerial impediments substantially influence resistance to the assimilation of sustainable practices. The insufficiency of governance frameworks, coupled with a deficit in accountability and strategic disarray, collectively obstructs the integration of sustainability into corporate operations [9,10]. Furthermore, cultural aversion to change, typically entrenched in traditional organizational methodologies, serves as a significant barrier to the acceptance of novel climate practices [3]. In light of these challenges, this research endeavors to delineate the primary barriers, opportunities, and exemplary practices pertinent to the efficacious implementation of corporate climate transition strategies, accentuating best-practice instances that may serve as benchmarks for enterprises and policymakers.

Conversely, the prospects of climate transition are equally noteworthy. The literature indicates that effective climate transition strategies require diversifying investments across goals and activities and that companies exposed to climate-related opportunities are encouraged to increase their investment in sustainable initiatives [11,12]. Entities that allocate resources toward research and development, such as Tesla and ABB, have illustrated how technological advancements can be harmonized with overarching global sustainability objectives [13,14]. To comprehensively address these matters, this study also aims to investigate pivotal opportunities that organizations may leverage to facilitate climate transition, namely, technological innovations, emerging markets, and support from stakeholders.

The discourse surrounding successful practices is extensively prevalent within academic literature. Notable instances, such as Google and IKEA, which have adopted a comprehensive approach to renewable energy utilization, exemplify the notion that energy efficiency not only mitigates carbon emissions but also substantiates the economic feasibility of sustainable methodologies [15]. Moreover, the engagement of stakeholders is underscored as a critical element, with enterprises like Patagonia serving as paradigms of climate transition through the implementation of circular economy strategies and intersectoral collaborations [15]. Consequently, this research endeavor seeks to delineate and organize the optimal practices pertinent to corporate climate transition, drawing on academic scholarship and empirical case studies of successful implementations.

Ultimately, it is paramount to acknowledge that corporate climate transition must integrate the tenets of social justice. Empirical investigations indicate that the inclusion of marginalized workers and communities in the advantages derived from this transition not only fosters equity but also fortifies the underpinnings of sustainable and resilient

development [16,17]. For example, corporations, in particular Unilever, exemplify how climate governance can be operationalized to yield tangible effects throughout value chains [15].

This study aims to identify the key barriers, opportunities, and practices for effective corporate climate transition, providing reference cases to guide firms and decision-makers. By integrating these elements, this study offers a practical and analytical basis for developing resilient strategies aligned with global climate goals.

Originality of This Study Compared to Previous Ones

The transition of corporate climates is extensively acknowledged as one of the most pertinent and extensively debated subjects in current academic discourse. This relevance stems from the need to align corporate operations with sustainability and climate goals. Previous scholarly investigations have examined particular dimensions of this transition, namely economic and technological impediments [2,18], prospects linked to innovation [13,19], and exemplary practices in energy efficiency [15,20]. Nevertheless, this study identifies a limited number of integrative reviews that simultaneously examine barriers, opportunities, and good practices in the corporate climate transition context.

In this context, the current study endeavors to address this underexplored intersection by providing an extensive analysis that consolidates these three essential dimensions within a single academic document. Grounded in a thorough literature review, this research aspires not only to delineate the obstacles encountered by enterprises but also to investigate opportunities that may facilitate the shift toward a low-carbon economy while concurrently underscoring effective corporate practices. Consequently, this study aims to contribute by offering an integrative analytical synthesis of themes that are often addressed in isolation, thereby supporting more informed discussions on corporate climate transition strategies.

It is observed that the majority of extant research endeavors address the subject matter pertaining to climate transition in a disjointed manner. For instance, whereas the investigations conducted by [2] examined the financial impediments associated with the upfront expenditures of sustainable technologies, the inquiries by [7] scrutinized the ramifications of current regulatory deficiencies in the enactment of climate policies. Concurrently, Ref. [13] deliberates on the significance of technological advancements, in particular electric vehicles, while [17] underscores the imperative to incorporate the principles of equitable transition. Each of these studies has contributed to the understanding of specific dimensions of the corporate climate transition; this study aims to advance the debate by analyzing them jointly through a structured and cross-cutting review.

The research question that underpins this investigation can be articulated as follows: What are the predominant barriers, opportunities, and exemplary practices for the efficacious execution of corporate climate transition strategies? Arising from this inquiry, the overarching aim of this study is to conduct a conventional literature review to discern, categorize, and evaluate these components, thereby providing both academic and practical contributions to the discourse on the topic.

The relevance of this study is directly associated with the global context of climate urgency, where companies are key to mitigating climate change and promoting a sustainable economy. In a scenario characterized by increasing demands from consumers, investors, and regulators, understanding the barriers and opportunities, as well as identifying successful practices, becomes essential to align corporate strategies with climate goals. Thus, this work seeks not only to advance the consolidation of dispersed findings in the academic literature but also to provide practical subsidies that assist business managers and policymakers in overcoming the challenges associated with climate transition.

In addition, the contribution of this study goes beyond the simple listing of studies. By highlighting concrete examples, including case illustrations of corporate adoption of renewable energy and innovation in the automotive sector, this work provides real-world evidence to inspire other companies and sectors. At the same time, the study reinforces the importance of social justice and inclusion principles, emphasizing that climate transition should benefit not only the environment but also vulnerable communities and workers affected by structural change.

In summary, this study seeks to contribute by offering a structured overview that brings together the different strands of climate transition literature. By consolidating barriers, opportunities, and successful practices, this work aims to offer useful guidance for the formulation of effective strategies that accelerate the transition to a sustainable economy.

2. Theoretical Foundation

2.1. Barriers in the Corporate Climate Transition

Barriers to corporate climate transition can be defined as factors that hinder, limit, or block the effective implementation of plans to mitigate greenhouse gas emissions and promote a low-carbon economy. These barriers can be classified into interconnected dimensions that include financial, political, cultural, technological, and operational challenges [1,6]. They illustrate the complex adjustments required to align business practices with sustainability objectives.

Economic and financial barriers include the unavailability of affordable capital for sustainable innovations, the high costs of green projects, and competition between fossil fuels and renewable energy sources [2]. Studies have shown that credit constraints and uncertainties regarding financial returns inhibit progress, especially in developing regions [12]. In the policy and regulatory arenas, challenges include a lack of coherence in climate policies, regulatory inconsistencies across jurisdictions, and high compliance costs, which constrain the adoption of sustainable solutions [5].

Cultural and organizational aspects are also important barriers. Resistance to change, lack of leadership in sustainability, and difficulties in integrating climate objectives into decision-making processes are the limiting factors [21]. In parallel, in the technological field, the phenomenon of "carbon lock-in"—where old systems hinder the adoption of new technologies—and the lack of appropriate infrastructure are widely discussed [18,22].

Data- and biodiversity-related barriers reflect the difficulty in effectively collecting, analyzing, and integrating climate information. According to [10], data gaps compromise the ability of organizations to assess the impact of their actions, while [1] warns that neglecting biodiversity can reduce the sustainability of corporate initiatives. Therefore, these barriers demand comprehensive solutions that combine technological innovations, effective regulations, and multi-sector collaborations.

2.2. Opportunities in the Corporate Climate Transition

In this research, the opportunities in corporate climate transition can be understood as possibilities for growth, innovation, and competitive advantage derived from aligning business practices with global sustainability goals. Such opportunities include sustainable investments, technological development, and strengthening organizational resilience [11,12].

Green financial instruments, such as "green bonds" and long-term debt securities, have proven effective in financing large-scale climate projects and diversifying portfolios [19]. The emergence of climate startups reinforces the role of innovation in creating disruptive solutions, notably carbon capture technologies and renewable energy sources [23]. In addition, the integration of climate scenarios into corporate planning increases companies' ability to mitigate risks and build trust among stakeholders [17].

The principles of a fair transition also provide significant opportunities to foster social inclusion and promote community acceptance. Companies that promote workforce requalification and engage local communities not only meet social demands but also strengthen their competitiveness in increasingly sustainability-oriented markets [17]. Thus, these opportunities encompass both the resolution of environmental challenges and the promotion of growth and innovation.

2.3. Best Practices in the Corporate Climate Transition

In this study, the best practices for corporate climate transition encompass a set of strategies that align environmental sustainability, economic viability, and social inclusion. These practices include the adoption of climate governance models, investments in technological innovation and energy efficiency, and strengthening cross-sector collaborations [1,21].

Climate governance stands out for the need to establish clear and scientifically based targets for emission reduction, integrating such goals into organizational structures [1]. Transparency in corporate reporting is equally crucial, as it promotes accountability and attracts investors aligned with climate demands [16]. Technological innovation, in turn, has demonstrated its impact through examples of Tesla and ABB, which led to the introduction of solutions that align sustainability with economic viability [13]. Companies that invest in energy efficiency and renewable sources also stand out for their ability to reduce emissions and optimize resources [15].

Practices, as in the case of the circular economy and nature-based solutions (NBS) represent integrated approaches to mitigate environmental impacts. The circular economy emphasizes the reuse and recycling of resources, while NBS promotes biodiversity conservation and carbon capture through initiatives such as reforestation and ecosystem restoration [1,14]. Natural capital management is a fundamental dimension that allows organizations to identify the risks and opportunities associated with the sustainable use of resources [15].

In summary, the best practices discussed show that integrated and strategically planned initiatives are essential for aligning climate goals with corporate objectives. The combination of robust governance, technological innovation, energy efficiency, and social inclusion positions companies as agents of change in an increasingly sustainability-oriented market.

3. Materials and Methods

The main objective of this study is to identify the main barriers, opportunities, and best practices for the effective implementation of corporate climate transition plans, highlighting good-practice examples of events that can serve as a reference for companies and policymakers. To achieve this purpose, we conducted a literature review based on the analysis of published materials, notably articles, books, and relevant digital sources, through a traditional literature review.

The review was performed using the Scopus, ScienceDirect, Web of Science, Reaxys, and Google Academic databases. Initially, we used the keyword “Climate transition plan”. However, we noticed that many studies addressed climate transitions outside the corporate context, as in the case of cities, municipalities, countries, or regions. Given the focus of this research on corporate climate transitions, we have refined our research strategy by developing specific keywords for each topic.

3.1. Corporate Climate Transition Barriers

For the topic of barriers to corporate climate transition, we used the following keywords:

- “Corporate Climate transition plan barriers, obstacles, or challenges”

- "Company Climate transition plan barriers, obstacles, or challenges"
- "Business Climate transition plan barriers, obstacles, or challenges"

After applying filters and eliminating irrelevant studies that did not specifically address barriers, obstacles, and challenges, there were 26 studies to dealt directly with the topic.

3.2. Corporate Climate Transition Opportunities

For the topic of corporate climate transition opportunities, we used the following keywords:

- "Corporate Climate transition plan opportunities"
- "Company Climate transition plan opportunities"
- "Business Climate transition plan opportunities"

After filtering and excluding studies that did not specifically address opportunities in the context of corporate climate transition, 19 studies were retained.

3.3. Best Practices for Corporate Climate Transition

Finally, for the topic of best practices and successful examples of corporate climate transition, we used the following keywords:

- "Corporate Good or best practices for climate transition and successful examples"
- "Company Good or best practices for climate transition and successful examples"
- "Business Good or best practices for climate transition and successful examples"

Following the same procedure, 18 studies were retained for this topic after filtration and analysis.

In addition to full-sentence queries, the search strategy also included combinations of relevant keywords using Boolean operators. The final sample was obtained after screening a larger initial pool based on thematic alignment and methodological relevance."

With the documents in hand, the first step involved reading each study individually to ensure its relevance to the research objectives. Subsequently, the content was analyzed, and data were extracted in relation to the types of barriers, opportunities, best practices, and successful examples discussed in these documents.

3.4. Categorization of the Results

During the analysis of barrier documents, we found that many studies presented similar barriers, obstacles, or challenges. Thus, we created categories based on the similarities between the types of barriers identified in the documents analyzed. The barriers were classified into the following categories:

- Economic and financial barriers
- Policy and regulatory barriers
- Cultural and organizational barriers
- Managerial and operational barriers
- Social and climate justice barriers
- Transparency and disclosure barriers
- Technological barriers
- Data barriers
- Stakeholder engagement barriers and supply chain
- Barriers related to biodiversity (nature)
- Other unclassified barriers

The identified opportunities were categorized as follows:

- Sustainable investments and financing
- Innovation and technological development
- Risk management and resilience

- Regulatory and compliance strategies
- Social impacts and just transition
- Other unclassified opportunities

The best practices identified were categorized as follows:

- Climate governance
- Transparency and reporting
- Technological innovation and digitalization
- Energy efficiency and renewable energy
- Stakeholder engagement and value chain
- Economic benefits and competitiveness
- Social justice and just transition
- Investments in nature-based solutions
- Other unclassified good practices

As the categorization was analytical and non-exclusive, several studies contributed to more than one thematic category. This overlap was expected and reflects the interconnectedness of the dimensions analyzed.

4. Results and Discussion

The following section presents and critically discusses the main findings of this literature review, organized into three analytical categories: barriers, opportunities, and best practices in corporate climate transition. These categories emerged from a structured synthesis of the selected studies and reflect the key themes that shape the implementation of climate transition plans in a corporate context. The analysis begins with a detailed examination of barriers, which represent the most frequently discussed challenges in the literature.

4.1. Results of Barriers in the Corporate Climate Transition

4.1.1. Economic and Financial Barriers

Economic and financial barriers are one of the main challenges to the effective implementation of corporate climate transition plans. An example of this is the need to align transition plans with sustainable financial instruments, for instance, green bonds and sustainability-linked loans, which require specialized knowledge and efficient use. Although they are promising tools, their adoption is still limited due to a lack of access and adequate understanding [1].

The impact of financial crises is also significant in this context. According to [9], financial crises make it difficult to invest in green technologies, leaving long-term effects on industrial emissions. For example, after the global financial crisis, regions that experienced greater bank deleveraging had 15% higher carbon emissions due to the fragility of the financial system [9]. This evidence reinforces the need for resilient financial solutions to sustain sustainable initiatives in unstable conditions. Credit constraints are also a significant barrier. Emerging market companies, often deprived of access to affordable financing, find it difficult to invest in sustainable technologies. Refs. [2,9] point out that such restrictions not only limit investments but also contribute to higher CO_2 emissions. Additionally, sunk costs related to existing facilities perpetuate the use of inefficient assets, discouraging the transition to low-carbon technologies [6].

The cost competitiveness of fossil fuels also poses a challenge. Ref. [6] shows that uncertainty about the availability and cost of renewable alternatives hinders the transition, while [12] discusses how the risk associated with carbon pricing can negatively impact companies that have not diversified their investments. Moreover, risk aversion on the part of investors and shareholders is often cited as an obstacle. Low-carbon projects,

often characterized by high initial costs and unproven technologies, encounter significant resistance from capital providers [6]. These challenges are further amplified by high implementation costs, which discourage smaller companies or those in developing regions, as observed by [4,19].

The perception of high costs and uncertain returns represents another barrier that prevents organizations from adopting sustainable solutions. Ref. [3] points out that companies often underestimate the long-term benefits of green practices due to the difficulty in translating climate change costs into tangible terms. This problem is exacerbated by financial regulations that require higher provisions for loans to low-carbon sectors, creating financial disincentives for sustainable innovation [24]. Market failures, particularly inefficiencies in consumer decisions and a lack of information on clean technologies, also contribute significantly to economic and financial barriers. Studies by [25] suggest that these failures require policy interventions to improve economic efficiency and facilitate the adoption of sustainable solutions. In addition, companies in countries like Pakistan often limit themselves to energy efficiency initiatives only when there are clear cost savings, which restricts the scope of more comprehensive practices [4].

Finally, barriers related to investment in new and sustainable technologies highlight the dilemmas faced by companies operating under financial constraints. Ref. [10] emphasizes that the difficulty of allocating resources for such investments, often due to uncertainty about returns, perpetuates dependence on outdated and less efficient technologies. Thus, economic and financial barriers are deeply interconnected, requiring solutions that integrate financial support, regulatory incentives, and education on long-term benefits to overcome these challenges.

4.1.2. Policy and Regulatory Barriers

Political and regulatory barriers are significant challenges that compromise the effective implementation of corporate climate transition plans. The absence of clear and consistent regulations, such as carbon pricing or significant regulatory mandates, is often cited as a major barrier. Ref. [5] argues that in many cases, the high costs of regulatory compliance and lack of robust mechanisms make it difficult for companies to adopt green innovations. This situation is aggravated by a regulatory ecosystem characterized by rules and metrics that do not always allocate climate resources efficiently [8].

The integration of new climate instruments into existing regulatory frameworks also poses significant challenges. Refs. [7,26] discuss how the inadequate integration of instruments, such as voluntary agreements and emission markets, can generate market inconsistencies and uncertainties, raising operating costs for companies. Internationally, these issues are exacerbated by regulatory inconsistencies between different jurisdictions, which impact the competitiveness of low-carbon products and hamper climate transition [6,27]. Political uncertainty is another central barrier, particularly in countries like China, where frequent changes in climate policies increase corporate emissions and compromise investments in research and development [27]. Ref. [18] reinforces that these uncertainties affect not only long-term planning but also the ability of companies to execute consistent strategies. This dynamic is reflected in the difficulty of integrating climate considerations into corporate planning, which is aggravated by the increasing complexity of regulatory standards [28].

A lack of clarity in policies and standards also creates significant obstacles. According to [7], ambiguities in verification schemes and climate standards can lead to greenwashing and a loss of consumer confidence. This problem is even more serious in contexts where there are no common definitions for low-carbon production practices, causing inconsistencies in the adoption of sustainable initiatives [29]. In addition, climate governance

policy faces structural limitations related to critical engagement with existing frameworks, such as the Science-Based Targets Initiative (SBTi). Ref. [30] warns that a lack of academic scrutiny can perpetuate power dynamics and compromise deeper structural changes. This reliance on corporate frameworks also overshadows the need for more systemic approaches involving coordinated government intervention [23].

Another relevant aspect is the cost of regulatory compliance, which directly impacts the financial viability of small and medium-sized enterprises. Ref. [5] highlights that high compliance costs limit the resources available for climate innovations, while (4) points to the absence of regulatory pressure as a factor delaying the adoption of sustainable strategies. Ref. [8] argues that without robust regulatory mandates, companies tend to misallocate their climate budgets, limiting the effectiveness of their initiatives.

Finally, excessive reliance on corporate innovation to address climate challenges is often criticized. Ref. [23] suggests that this excessive focus on market solutions may distract attention from broader and coordinated policy changes, which are essential for an effective climate transition. In short, policy and regulatory barriers present interrelated challenges that require integrated, multi-sector solutions to create an enabling environment for corporate climate transition.

4.1.3. Managerial and Operational Barriers

Managerial and operational barriers are key challenges that directly impact the effective implementation of climate transition plans. The prevention of dependencies on high-emission technologies, for example, requires an operational approach that ensures the future flexibility of companies. According to [1], such prevention is often hampered by the inadequate structuring of existing systems, which can create technological blockages. At the same time, Ref. [7] discusses the challenges of scaling carbon removal technologies, which are often not developed economically or operationally viable, limiting the organizations' climate response capacity.

Ref. [31] argues that this dependence may result in a lack of structural change within companies, creating a false sense of progress while emissions remain high. In this context, corporate governance plays a central role, as robust accountability structures are critical for monitoring progress and adjusting strategies as necessary [1]. A frequent obstacle is the difficulty in integrating climate transition plans into companies' core strategies. Ref. [1] points out that this lack of integration leads to ineffective implementation, especially when accompanied by poor quality management. Ref. [9] points out that weak management prevents investments in green technologies and hinders progress toward corporate sustainability. In specific sectors, as in the case of zero-energy construction, managerial barriers overcome technical challenges, showing how leadership can be a limiting factor for innovation [32].

Setting climate targets, particularly net-zero targets, also presents considerable operational difficulties. These goals require a balance between ambition and practicality, considering regulatory changes and market dynamics. Ref. [1] points out that operational complexity can compromise the achievement of these goals. In addition, Ref. [33] highlights that adaptations to new frameworks, notably supply chain governance, require significant changes in operations, creating additional organizational and operational barriers. Another barrier is the need to develop performance metrics and key indicators (KPIs) that are aligned with climate demands. Ref. [1] suggests that the lack of transparency and accountability hinders the implementation of such systems, while [7] emphasizes the importance of ensuring integrity and credibility in corporate climate strategies. In highly integrated sectors, as in the case of the chemical industry, Ref. [6] warns that energy efficiency achieved through integrated clusters may become a barrier to the adoption of new technologies due to the difficulty in changing established systems without significant interruptions.

Finally, the challenges in implementing climate tools and risk management solutions illustrate how operational barriers can be amplified by integration complexity and a lack of standardized training. Ref. [34] highlights interoperability problems in climate adaptation tools, while [35] points to systemic failures in collaborations between companies and research institutions, hampering innovation. These examples show that managerial and operational barriers are interconnected, requiring integrated solutions to overcome the challenges of climate transition.

4.1.4. Social and Climate Justice Barriers

Barriers related to social and climate justice have emerged as critical issues in the transition to a low-carbon economy, highlighting the social impacts of decarbonization. In general, it is observed that the high social costs of this process can deepen pre-existing inequalities, compromising both economic growth and social stability. Ref. [31] highlights that in regions or sectors highly dependent on fossil fuel industries, climate transition can result in significant job losses, exacerbating social vulnerabilities.

In this context, it is important to highlight the concept of a just transition, which emphasizes the need to include social aspects in climate strategies. According to [1], involving stakeholders, namely workers and affected communities, is essential to mitigate the adverse impacts of transition by ensuring support for the most vulnerable groups. This approach requires not only a consistent dialogue but also the implementation of initiatives, such as retraining and rehousing programs for workers displaced by structural changes in the labor market. Ref. [31] argues that the lack of clear plans for a just transition not only increases resistance to climate plans but also compromises the credibility of net-zero emissions strategies.

At the same time, it is noted that the absence of concrete initiatives aimed at social justice can trigger a vicious circle of mistrust between stakeholders and corporations. Thus, ensuring that social impacts are considered in a systematic manner is crucial for the effective implementation of climate measures. In short, it is necessary that companies not only recognize the potential social impacts of their climate actions but also develop solutions that promote social inclusion and economic stability during the transition process.

4.1.5. Transparency and Disclosure Barriers

Barriers to transparency and disclosure pose significant challenges to the effective implementation of corporate climate transition plans, directly impacting the credibility and effectiveness of climate action. First, it was observed that the complexity of reporting emissions, especially in scopes 1, 2, and 3, represents a central barrier. Ref. [36] highlights that this complexity makes it difficult to accurately measure and disclose corporate carbon performance, which is important for effective climate transition. At the same time, distortions and concealment of data in sustainability reports compromise stakeholders' confidence, even before initiatives in particular the Global Reporting Initiative, which seeks to standardize reports [36].

In this context, the influence of third-party leadership metrics also deserves attention. Ref. [8] argues that these metrics may prioritize certain strategies over others, which can limit the overall effectiveness of emission reduction actions. In a similar vein, the reliance on financial and non-financial indicators is often mentioned as a challenge. Ref. [28] shows that many indicators, including green spending, have limited effectiveness in reducing emissions, making it difficult to identify effective strategies. This limitation is amplified by the absence of standardized metrics to measure and report emission reductions, which can lead to inconsistent efforts and a reduction in corporate liability [28].

At the same time, it is important to highlight the role of emerging mandatory disclosure programs. Refs. [30,37] point out that existing reporting frameworks often fail to capture the complexity of climate change, highlighting the gaps in corporate strategies. Thus, there is a need for more robust mandatory reporting to support the transition to net-zero emissions. However, meeting the growing demand for non-financial reporting, namely climate-based risk analysis, requires an expansion of corporate reporting frameworks, which can be resource-intensive and operationally complex [28].

From another perspective, challenges related to the credibility of climate tools have also been widely discussed. The use of carbon credits as a complementary measure presents difficulties in guaranteeing their credibility and effectiveness, as pointed out by [1]. In addition, ensuring transparency in reporting and third-party validation is critical for building trust among stakeholders. This includes clear disclosure of methodologies, assumptions, and progress, as reinforced by [1]. In general, it is observed that gaps in the integration of climate data into corporate strategies and the difficulty in capturing comprehensive sustainability metrics directly impact the ability of companies to evaluate the effectiveness of their initiatives. Ref. [28] highlights that these gaps undermine climate risk management and compromise progress toward climate goals. Thus, ensuring transparency and standardization in corporate reporting is presented as an essential condition for advancing climate transition.

4.1.6. Stakeholder Engagement Barriers and Supply Chain

Barriers related to stakeholder engagement and supply chain management pose significant challenges to the effective implementation of corporate climate transition plans. First, it is observed that misaligned incentives often prioritize short-term financial gains over sustainability goals. Ref. [36] highlights that this dynamic can promote greenwashing practices, compromising the authenticity of climate actions and damaging the confidence of stakeholders. Thus, it is essential to review incentive structures to ensure greater coherence between financial and climate objectives.

In this context, the effective engagement of stakeholders emerges as a central dimension. Ref. [38] argues that the active involvement of stakeholders contributes to green competitiveness while facilitating the integration of suggestions and effective conflict management. At the same time, Ref. [12] emphasizes that the pressure exerted by investors, consumers, and regulatory bodies often presents challenges for companies, which must balance these external demands with their operational and financial capabilities. Thus, building solid relationships with stakeholders is an essential strategy. Ref. [39] argues that addressing the concerns of these groups not only improves decision-making but also ensures that no group is excluded from climate transition processes.

In parallel, the complexity of supply chain governance presents another significant hurdle. Ref. [33] notes that managing sustainable supply chains requires coordination among stakeholders with diverse interests, which can make it difficult to implement consistent climate strategies. Additionally, Ref. [40] highlights that many companies' narrow focus on direct emissions ignores indirect emissions along the supply chain, limiting the overall impact of climate initiatives. This trend is reinforced by climate targets that disregard indirect emissions related to customer activities, significantly underestimating the corporate carbon footprint.

Another important point is the reliance on partners in the supply chain to support sustainability efforts. Ref. [18] argues that this dependence can be challenging when partners lack adequate capabilities or are not aligned with the sustainability goals of companies. In this sense, it is essential that organizations develop mechanisms to strengthen the capacities of their partners and align objectives throughout the supply chain. In general, it is noted

that the barriers to stakeholder and supply chain engagement are interconnected, reflecting both operational and strategic challenges. Overcoming these barriers requires integrated solutions that align incentives, promote collaborative relationships, and expand the scope of climate goals, ensuring that all dimensions of the value chain are effectively addressed.

4.1.7. Technological Barriers

Technological barriers pose substantial challenges to the effective implementation of corporate climate transition plans. First, it is observed that the "carbon lock-in" phenomenon considerably limits the transition to low-carbon alternatives. Energy-intensive industries face high sunk costs and technological incompatibility, which makes it difficult to replace old systems with new technologies. In this context, Ref. [22] reinforces that dependence on outdated technologies perpetuates this blockage, creating structural barriers to innovation and the adoption of more sustainable solutions.

In parallel, the lack of adequate tools for developing low-carbon products is a significant barrier; Ref. [18] argues that this gap prevents compliance with sustainability standards and limits the ability of companies to innovate consistently. This challenge is even more evident in small and medium-sized enterprises (SMEs), which face additional technological and operational difficulties [41]. Together, these factors illustrate how the lack of adequate technological infrastructure can create inequalities in access to climate transition. Another relevant aspect is the lack of available low-carbon technologies. Ref. [29] points out that this limitation prevents companies from effectively reducing their carbon footprints, even when there is a willingness to adopt a sustainable solution. Ref. [35] complements this perspective by pointing out that the lack of information on clean technologies also hinders the adoption of sustainable practices, even when the technologies are technically accessible. This information gap contributes to market failures that hinder the implementation of climate solutions.

Furthermore, the technological incompatibility between existing systems and new solutions is also often mentioned as a substantial barrier. Ref. [6] explores how technologies such as electrification and carbon storage cannot often be integrated simultaneously, which reduces efficiency and makes it difficult to transition to sustainable alternatives. Similarly, Ref. [34] notes that climate adaptation tools face interoperability problems, making the integration process with other planning software inefficient and costly. Finally, it is important to highlight that technological barriers are not limited only to the lack of infrastructure or the incompatibility of systems. They also include organizational and market dynamics that make it difficult to adopt sustainable solutions on a large scale. Thus, overcoming these barriers requires not only the development of new technologies but also the effective integration of information and solutions adapted to the needs of organizations.

4.1.8. Data Barriers

Data-related barriers represent a significant challenge to the effective implementation of corporate climate transition plans, as proper information management is essential for tracking sustainability metrics and making informed decisions. In this context, Ref. [10] points out that many companies face difficulties in collecting, analyzing, and efficiently using data, which limits their ability to evaluate progress toward climate goals. Thus, it is observed that gaps in data management can compromise both the identification of priority areas and the effectiveness of implemented actions. At the same time, it is important to highlight the need to incorporate prospective climate data into corporate planning and reporting. Ref. [28] argues that the lack of such incorporation prevents companies from anticipating and responding effectively to climate risks, compromising risk management and organizational resilience. In this sense, the lack of relevant and well-integrated data

not only limits the adaptability of companies but also reduces their competitiveness in an increasingly sustainability-oriented market.

In general, it is noted that the data barriers are closely linked to the efficiency of corporate climate strategies. Inadequate management and the lack of integration of climate information in decision-making processes reveal the need for systemic solutions and investment in data infrastructure. Thus, overcoming these barriers requires not only technological advances but also a more structured approach to the use and management of relevant information, enabling organizations to operate more effectively and resiliently in a constantly evolving regulatory and market environment.

4.1.9. Biodiversity-Related Barriers (Nature)

Barriers related to biodiversity and nature highlight the complexity of integrating broader environmental considerations into corporate climate transition plans. In general, it is observed that companies often neglect non-climate-related sustainability impacts, notably biodiversity and social equity. According to [1], this omission may compromise a holistic approach, as organizations can cause unintended harm in other areas by focusing exclusively on climate goals. In this context, it is important to highlight that the integration of these broader considerations requires strategic planning and the ability to comprehensively assess the impact of climate action on biodiversity. Companies that fail to incorporate these broader dimensions may face stakeholder resistance and reputational risks and compromise the long-term sustainability of their initiatives. Thus, it is necessary for organizations to develop more integrated approaches to ensure that biodiversity impacts are mitigated as they advance their climate goals.

Finally, it is noted that overcoming these barriers requires the implementation of more robust governance structures, which include metrics to assess the impacts on biodiversity and mechanisms to align corporate goals with Sustainable Development Goals. Thus, a more holistic and integrated approach can help companies address the challenges associated with biodiversity as they advance their climate transition strategies.

4.1.10. Other Barriers Not Rated

Unclassified barriers include challenges that, although not directly categorized into specific domains, significantly influence the implementation of corporate climate transition plans. First, it is observed that exposure to unpredictable climate shocks may represent an indirect obstacle, diverting financial resources and attention from sustainability-oriented initiatives. Ref. [9] points out that, in the face of extreme weather events, companies often prioritize emergency solutions, which reduces the availability of resources for investment in green technologies. Thus, it is noted that these climate shocks not only create immediate operational challenges but also compromise long-term progress toward decarbonization.

At the same time, the maturity of corporate environmentalism varies significantly between industrialized and developing countries, reflecting substantial differences in the strength and content of the barriers faced by companies. Ref. [4] argues that companies located in developing countries often deal with inadequate infrastructure, less robust regulations, and limited financial resources, factors that amplify the challenges of implementing sustainable climate practices. In contrast, companies in industrialized countries, although operating in more developed regulatory contexts, face barriers related to the transition of consolidated systems and the need to meet the stricter expectations of stakeholders.

In general, it is observed that these barriers, although not widely discussed in the literature, play a relevant role in influencing the ability of companies to plan and implement their climate strategies. Thus, it is important to consider both the immediate impacts of extreme climate events and the structural differences between regional contexts in order

to fully understand the challenges faced by organizations in their quest for an effective climate transition.

The list of identified barriers has been classified and is available in Supplementary S1 of the Supplementary Document.

4.2. Results of Corporate Climate Transition Opportunities

4.2.1. Sustainable Investments and Financing

The transition to a climate-resilient economy has led to significant changes in investment modalities and corporate finance practices, highlighting a growing inclination toward more sustainable methodologies. Corporations located in nations with advanced financial infrastructure show a pronounced propensity to allocate resources to low-carbon technological innovations, influenced by economic motivations and the imperative to meet the global environmental objectives outlined in international agreements [11]. Such allocations not only increase the competitive stature of companies but also generate opportunities to diversify portfolios related to sustainable infrastructure, thus alleviating the risks associated with regulatory ambiguities [11,12].

A widely adopted strategy for facilitating climate initiatives is financing them through long-term debt instruments. This methodology provides financial stability, especially for projects characterized by their large scale and complexity [11]. At the same time, several companies are leveraging internal financial resources to accelerate the integration of green technologies, ensuring greater operational autonomy and strict oversight of expenditures. Furthermore, diversifying investments across various environmental initiatives has proven effective in mitigating the impact of climate-related risks, namely carbon pricing, while adhering to the stipulations of environmental regulations [13].

The notable surge in investments directed toward startups dedicated to climate solutions deserves special attention. The market has seen a 2000% increase in transaction volumes and a 2811% increase in capital inflows, indicative of investor confidence in the potential of these companies to lead the transformation of the business landscape [19]. Furthermore, public policy frameworks, especially in Europe, have played a key role in increasing access to sustainable finance resources. Initiatives such as sustainability-focused funds and green bonds offer lucrative financial conditions for projects that are consistent with climate goals [42,43].

Green finance instruments, such as sustainability-linked loans and climate bonds, have received substantial scrutiny. Corporations that exhibit high ESG (Environmental, Social, and Governance) metrics tend to attract investors who prioritize sustainability, thus facilitating access to capital on favorable terms [43,44]. Furthermore, the adoption of sustainable practices has a beneficial effect on corporate credit ratings, leading to reduced financial burdens and an increased ability to access strategic resources [43]. These advances are further driven by innovations in financial models that integrate sustainability and profitability, thereby promoting greater viability for climate transition initiatives [43].

Companies that emphasize just transition methodologies have also benefited from financing schemes that aim to generate positive social outcomes. ESG funds and incentives geared toward a just transition not only expand investor demographics but also advocate social inclusion and community resilience [17]. Furthermore, government incentives, such as subsidies and tax breaks, increase the competitive advantage of companies pioneering green solutions by facilitating the modernization of energy infrastructure and ensuring reliable access to renewable energy sources [45,46].

Diversifying environmental portfolios contributes to financial robustness, thereby protecting companies from market fluctuations and the erratic nature of climate-related regulations. Companies committed to exploring sustainable markets are positioned to meet

the growing expectations of consumers and investors for environmentally friendly products and services, thus ensuring operational viability even under adverse conditions [12]. Consequently, sustainable investments and financing not only serve as mechanisms for reducing climate-related risks but also present an opportunity to facilitate the transition of the business sector to a low-carbon economy.

4.2.2. Innovation and Technological Development

The climate transition imperative has catalyzed advances in technologies and business paradigms aimed at decarbonization, with startups playing a key role in deploying disruptive innovations to meet the demands of a transitioning market [19]. These startups are leading the advancement of environmentally sustainable products and energy-efficient technologies, thus helping companies achieve net-zero emissions goals while promoting adaptive strategies that increase resilience amid the challenges posed by climate change [13,47]. Collaborative efforts between established companies and startups increase the efficiency of climate technology development by combining financial capital and technological expertise, thus serving as a catalyst for industrial transformation. Furthermore, the emergence of climate innovation clusters facilitates the exchange of knowledge and resources between startups, academic institutions, and large companies, generating a virtuous cycle of technological advancement [19].

Directed investments in green technologies, in particular carbon capture mechanisms and renewable energy sources, have enabled companies to meet regulatory mandates and market expectations. The transition to renewable energy sources, such as solar and wind, not only produces substantial reductions in greenhouse gas emissions and long-term energy costs but also generates opportunities to modernize infrastructure and improve operational eco-efficiency [23,45]. Organizations that adopt more energy-efficient operational modalities not only minimize waste but also increase their productivity and market competitiveness [23].

Collaboration among multiple stakeholders is essential for the advancement of climate innovation. Governments, corporations, and academic institutions have come together to create solutions that align with net-zero emissions goals, thus promoting the development of new business models, including circular economy and clean production methodologies [13,47]. The assimilation of emerging technologies has also proven significant, allowing companies to formulate adaptable products and processes that effectively respond to market sustainability demands [13,47]. The application of digital technologies for process monitoring and optimization has emerged as a critical catalyst for sustainable innovation. Instruments, in particular the "Enterprise Analytics Tool" facilitate organizations in identifying climate impacts associated with business indicators, promoting adaptive measures and strategic foresight [43,48]. Furthermore, the establishment of markets for sustainable technologies and services has spurred sectors dedicated to climate change mitigation and adaptation, thus solidifying an economic base that is increasingly aligned with global climate goals [43].

Replacing fossil fuels with renewable energy sources remains a primary goal across multiple sectors. Companies that allocate resources to solar, wind, and other clean technologies not only significantly reduce their greenhouse gas emissions but also attract the attention of investors focused on environmental, social, and governance (ESG) criteria, thereby increasing their competitive advantage in markets that prioritize sustainable practices [42,43]. Synergistic innovations between corporations and external stakeholders have facilitated the emergence of transformative solutions and new business models that effectively address climate-related challenges [19,46]. Strengthening innovation ecosystems

and fostering sustainable markets reinforces the role of companies in leading the climate transition and, ultimately, establishing a low-carbon economy.

4.2.3. Risk Management and Resilience

Risk management and resilience enhancement are key concerns for companies facing escalating climate threats and intensifying global regulatory imperatives. Sustainable investments are recognized as a crucial strategy for mitigating risks related to extreme weather events and carbon prices, enabling organizations to strengthen their resilience in anticipation of future uncertainties. Within this framework, diversifying energy portfolios is a prevalent tactic that reduces susceptibility to fluctuations in the carbon market while increasing the financial robustness of companies operating in a fluid regulatory environment [12].

Organizations that incorporate climate scenarios into their strategic decision-making demonstrate an improved ability to anticipate and mitigate environmental impacts, thus ensuring the longevity of their operational activities. This methodology not only increases operational effectiveness but also increases the trust of investors and stakeholders, who prioritize companies that demonstrate transparency in their climate disclosures and dedication to sustainable goals [42,47]. Comprehensive documentation of emissions and environmental initiatives, in addition to meeting regulatory requirements, promotes a favorable corporate image, which translates into competitive advantages in international markets [44].

The integration of regional and sectoral climate data into corporate structures represents another significant dimension of risk management. By leveraging region- and sector-specific information, organizations can adapt their operations to local requirements, promoting more effective solutions that are consistent with market requirements [28]. This methodology is further enhanced through collaborations with external stakeholders, which facilitate the co-creation of adaptive strategies and promote greater acceptance of the measures implemented [28,48].

In addition, the emphasis on sustainable initiatives aimed at mitigating climate risks empowers organizations to reconceptualize challenges as pathways to expansion. Resilient business models that integrate sustainability principles increase the ability of organizations to respond skillfully to climate and economic pressures [46]. Exemplary examples include the modernization of industrial methodologies, which aim to improve energy efficiency and reduce emissions, as well as the implementation of carbon capture and storage (CCS) systems, which facilitate the neutralization of emissions and the achievement of global climate goals [45].

Another critical component is the improvement of climate transparency. Consistent reporting on environmental risks and initiatives not only fosters trust among stakeholders but also simplifies access to sustainable financial resources. This alignment is particularly vital for organizations seeking to establish a reputation as changemakers in the global arena [44,46]. Encouraging collaborative innovation between corporations and external stakeholders is also pertinent to cultivating disruptive solutions and new business paradigms that effectively address the challenges posed by climate change [28]. Ultimately, companies that engage in diversifying their investments in emerging technologies, notably green hydrogen and smart water infrastructure, increase their resilience amid environmental and economic crises [43]. Modifying industrial processes to reduce emissions, together with the implementation of eco-efficient solutions, has emerged as a critical building block for the governance of climate-related risks [42]. Consequently, integrating mitigation, transparency, and collaboration strategies empowers organizations to transform obstacles

into lasting competitive advantages while simultaneously promoting the development of a low-carbon economy.

4.2.4. Regulation and Compliance Strategies

The transition to a climate-resilient economy has forced companies to incorporate regulatory and compliance considerations into their strategic frameworks, thus highlighting the growing importance of aligning with international climate goals. The Paris Agreement, for example, highlights the imperative of limiting the global temperature rise to 1.5 °C, thus motivating organizations to implement measures aimed at achieving net-zero emissions. Companies that recalibrate their operational practices to align with these scientifically proven goals gain substantial competitive advantages and strengthen their status as sustainability vanguards [12,49]. This alignment not only ensures long-term sustainable performance but also meets stakeholder demands for environmental responsibility and transparency.

Adherence to regulations has emerged as a key competitive lever for attracting investors who prioritize environmental sustainability. Organizations that adopt transparent practices to disclose climate-related risks and adhere to international regulations demonstrate greater credibility and stability, establishing a distinct advantage in highly competitive markets [49]. Furthermore, the regulatory impetus to achieve net-zero emissions by 2050 has led entities to meticulously evaluate their value chains and production methodologies to ensure compliance with emerging climate policies [42]. This strategic adaptation is crucial for mitigating regulatory risks, minimizing potential penalties, and aligning with the expectations of environmentally conscious consumers and investors [18].

Corporations that implement sustainable business structures are also gaining greater relevance within this paradigm. By positioning sustainability as a core component of corporate operations, organizations can align with regulatory bodies and cultivate the trust of stakeholders concerned with climate-related issues [45]. Furthermore, this methodology increases organizational agility, enabling companies to respond quickly to changes in climate policy, ensuring not only regulatory compliance but also strategically positioning themselves to capitalize on emerging market prospects [19].

An additional critical dimension is the ability of organizations to exert influence over climate policymaking. Active participation in dialogue with policymakers enables companies to shape environmental regulations that reinforce sustainable practices, thus strengthening the nexus between regulatory frameworks and corporate strategy [46]. This engagement further ensures that companies are ideally positioned to influence regulatory outcomes in favor of sectors aligned with climate transition.

Ultimately, mitigating regulatory risks through proactive initiatives increases organizations' resilience in environments characterized by heightened regulatory scrutiny. Entities that commit resources to reassess their operations to comply with evolving environmental standards not only avoid penalties but also solidify their reputation as catalysts for change in an increasingly sustainability-driven global economy [18]. These strategies, coupled with sustainable business models and organizational agility, ensure that companies not only meet their regulatory obligations but also pave the way for a low-carbon future.

4.2.5. Social Impacts and Just Transition

The transition to a climate-resilient economy, while imperative to address the challenges posed by climate change, simultaneously creates obstacles and perspectives for companies regarding social ramifications and equitable transition. Aligning corporate strategies with international climate objectives promotes a favorable perception among stakeholders, thus improving corporate reputation and attracting consumers and investors

who prioritize responsible environmental and social management [23,49]. By implementing innovative and sustainable methodologies, organizations not only enhance their public image but also solidify their status as pioneers of sustainability practices [12,19].

Incorporating sustainability into corporate structures generates substantial value for organizations, allowing them to attract demanding consumers and investors who emphasize ESG (Environmental, Social, and Governance) criteria. This strategy, in turn, catalyzes the reconfiguration of business models, aligning operational practices with sustainability principles and regulatory mandates, in particular those outlined in the European Green Deal [13,42]. Furthermore, responsiveness to the demands of consumers concerned about environmental impacts facilitates the emergence of new market segments, promoting green products and services that leverage eco-efficient technologies [23].

Climate transition provides even more significant avenues for job creation in green sectors, including renewable energy, sustainable transportation, and green infrastructure [18]. This growth requires the establishment of professional retraining initiatives, ensuring that individuals affected by the transition have access to new job prospects in sustainable industries [17]. Companies that champion workforce empowerment efforts reinforce the social discourse and advocate for an inclusive and equitable transition, addressing critical issues related to social and economic justice [17].

Engaging local communities is also key to facilitating a just transition. Collaborations with marginalized communities enable organizations to execute joint initiatives that improve climate resilience and produce favorable social outcomes [18,50]. This methodology strengthens the perception of corporate social responsibility, contributing to better integration of companies into the local contexts in which they operate [46]. In addition, strategies such as climate-smart agriculture, which promotes the judicious use of water resources and effective waste management, are recognized as effective approaches for mitigating environmental impacts while increasing productivity [43].

The adoption of just transition principles not only mitigates resistance to change but also increases social acceptance of corporate strategies. Just transition frameworks, by advocating for the incorporation of social justice into business operations, ensure greater stakeholder buy-in and generate a sustainable impact in global markets [17]. This paradigm is further reinforced by enhanced social dialogue that encompasses workers, unions, and affected communities, fostering consensus and legitimacy regarding the necessary transformations [17].

Ultimately, companies that adopt ethical and sustainable methodologies not only enhance their public image but also increase their competitive advantage in an evolving global marketplace [18]. Allocations to sustainable technologies, namely clean transportation and robust infrastructure, create avenues for expansion while meeting the requirements of demanding consumers [12]. Consequently, merging sustainability-focused strategies, incorporating social justice principles, and proactively engaging with communities and workers lay the foundation for a prosperous and equitable climate transition.

4.2.6. Other Unclassified Opportunities

The ongoing climate transition generates a spectrum of opportunities that do not fit into the previously outlined categories but have a significant impact on corporate sustainability and economic advancement. Among these opportunities is collaboration between the public and private sectors, which facilitates the implementation of large-scale climate initiatives. Such partnerships optimize resource utilization, enhance sustainability efforts, and promote integration between the public and private domains, thereby increasing the effectiveness and beneficial outcomes of these initiatives [43].

The advent of climate transition metrics serves as a mechanism for companies to assess and recalibrate their sustainability frameworks. These indicators not only provide a means of monitoring operational performance but also support informed decision-making processes, ensuring the alignment of corporate activities with overarching global climate goals [44]. Furthermore, engaging multiple stakeholders, including consumers, communities, and business partners, strengthens strategic partnerships that collaboratively and effectively advance climate initiatives [42,46].

The development of process models based on climate scenarios represents another important opportunity. Instruments such as climate inventories and prioritization assessments provide companies with methodologies to incorporate climate change data into their strategic frameworks. This strategic integration not only enhances business planning capabilities but also strengthens organizational resilience in a changing environmental landscape [28]. At the same time, decentralized solar and storage solutions present sustainable alternatives for isolated regions, thus improving access to clean energy while reducing operational costs [43].

In the real estate domain, the proliferation of green buildings represents a notable opportunity. Sustainable construction methodologies, including energy efficiency and the use of materials with minimal environmental impact, not only meet regulatory and market expectations but also elevate companies to leadership positions in sustainability [43]. These initiatives not only contribute to the mitigation of carbon emissions but also generate value for environmentally conscious consumers and investors, thus harmonizing economic and ecological imperatives.

Collaboration between corporations, government entities, and local communities further reinforces climate initiatives. This multifaceted cooperation allows for the implementation of sustainable solutions that meet local requirements while promoting regional development [42]. In this framework, the fusion of innovative strategies and stakeholder engagement emerge as key elements for progressing towards a low-carbon economy.

The list of identified opportunities has been classified and is available in the Supplementary Information (S1).

4.3. Best Practices for Corporate Climate Transition

4.3.1. Climate Governance

Climate governance is a key component of moving toward a low-carbon future and alleviating the impacts of climate change. Contemporary research highlights the need to set explicit goals, incorporate fair transition principles, and promote corporate responsibility as key strategies for the effective implementation of climate initiatives. The academic discourse is unanimous in affirming that entities adopting comprehensive climate governance frameworks can synchronize their strategies with global environmental imperatives, thus ensuring long-lasting competitiveness and resilience [1,18].

The articulation of distinct and ambitious goals is widely recognized as one of the essential facets of climate governance. Research, particularly that conducted by [1], shows that organizations that commit to net-zero emissions targets, according to scientific references, exhibit not only credibility but also a substantial impact on emission reductions. In addition, the assimilation of climate transition strategies into corporate structures is essential to ensure organizational coherence and effective mobilization of resources. As postulated by [21], the alignment of internal and external corporate initiatives is vital for establishing a robust support network encompassing clients, suppliers, and policymakers. For instance, the Envision Group (China) has successfully embedded climate targets into its global operations by integrating AI and digital tools to align governance with decarbonization pathways.

Accountability and transparency are also important issues in the field of climate governance. Research indicates that establishing independent third-party verification mechanisms and disseminating regular reports increases stakeholder confidence while promoting corporate responsibility [1]. An example of Tata Power (India) illustrates this practice: the company publicly discloses its sustainability metrics and regularly engages in third-party audits to ensure transparency across its renewable energy investments. In addition, [21] emphasizes the strategic management of the climate policy timeline as an effective approach to ensure that organizations remain proactive and responsive to evolving regulatory scenarios.

The academic literature further emphasizes the importance of visionary leadership in facilitating climate transition. Ref. [51] states that organizations that elevate sustainability to executive-level priorities are more likely to meet their climate goals. This notion aligns with the imperative of cultivating a long-term vision and implementing regional policies based on innovation, as emphasized by [52]. The incorporation of fair transition principles into corporate operations is another vital aspect outlined in the literature. Ref. [17] argues for the need to ensure that climate initiatives are inclusive, recognizing workers' rights and the needs of marginalized communities. This principle is essential to ensure that economic and technological advances yield broad social benefits.

Recent academic research has also highlighted the importance of coordinated global climate governance. Ref. [20] states that the formulation of international agreements and regulatory support structures can stimulate the adoption of sustainable practices on a global scale. In addition, proactive management of industrial transition, as discussed by [53], is indispensable for addressing the long-term challenges associated with implementing effective climate policies. Companies like Natura &Co (Sao Paulo, SP, Brazil) have demonstrated leadership in aligning global governance frameworks with inclusive transition efforts by promoting biodiversity, regional sustainability, and social equity in their corporate strategies. In the final analysis, the application of structured structures to assimilate climate considerations into corporate strategies has received significant attention in academic discourse. Ref. [28] outlined a comprehensive eight-step methodology that encompasses inventory assessments, implementation of strategic initiatives, and process strengthening, enabling organizations to systematically address climate-related risks and opportunities.

In short, climate governance is a complex domain that requires a fusion of visionary leadership, flexible policies, and a participatory approach. Previous research provides critical insights that form the basis for future initiatives, underlining the imperative of incorporating climate considerations at all levels of an organization.

4.3.2. Transparency and Reporting

The concepts of transparency and reporting are critical components of the corporate transition to climate resilience, as they promote accountability, build trust among stakeholders, and establish a basis for evidence-based policymaking. The existing body of literature highlights several key practices, ranging from the establishment of rigorous metrics to compliance with international frameworks, all aimed at ensuring transparency in corporate climate initiatives.

The application of extensive performance metrics and key performance indicators (KPIs) is recognized as a vital practice for ensuring accountability and facilitating the monitoring of progress. As stated by [1], these metrics should not only present transparency but also allow comparability between industry peers, thus allowing continuous improvement and advancement of a higher performance standard. In addition, this methodology simplifies the creation of benchmarks, allowing companies to evaluate their climate strategies against global best practices. A notable example is the Mahindra Group (India), which pub-

licly discloses detailed environmental KPIs across its automotive and agricultural divisions, fostering comparability across industries.

Engagement in international initiatives, such as the UN Global Compact and the Principles for Responsible Investment (PRI), is identified by [13] as an effective strategy for aligning corporate efforts with global sustainability goals. These initiatives not only advocate transparency but also reinforce responsibility for environmental and social performance, motivating companies to adopt stricter practices and perpetually refine their operations. Companies such as Vale (Brazil) have aligned with these global initiatives and reinforced their transparency through integrated reporting frameworks based on GRI and SASB standards, particularly in the mining and logistics sectors.

Another important factor is the accessibility of accurate information on methodologies and opportunities for sustainable practices. Ref. [54] argues that companies equipped with comprehensive data on financial and non-financial incentives, as well as emerging market perspectives, are better positioned to make sound decisions and make a successful transition. This category of information is particularly relevant in dynamic markets, where the demand for climate solutions is constantly changing.

Comprehensive and transparent disclosures are considered a distinctive feature of high-performance organizations. According to [14], these entities provide more extensive reporting on their climate strategies than their competitors, which not only increases their credibility but also contributes to a favorable influence on policy formulation. This statement is corroborated by [16], who emphasizes that transparency serves as a fundamental element to ensure the confidence of consumers and investors, thus ensuring support for sustainability ventures. For example, SK Hynix (Icheon, South Korea) stands out for its extensive climate reporting, detailing its emissions, targets, and governance structure across its global operations. In addition, transparency is indispensable for cultivating stakeholder trust. Ref. [1] states that consistent and responsible reporting of progress toward climate goals not only increases confidence but also reinforces companies' commitment to sustainability. This perspective is further supported by [16], who indicates that companies that adopt transparent reporting are more likely to attract investors committed to the green transition.

In conclusion, the literature on transparency and reporting illustrates that these practices are essential for promoting accountability, establishing credibility, and positively impacting global advances in sustainability. Through the implementation of rigorous metrics, participation in international initiatives, and the provision of detailed disclosures, companies can not only improve their environmental performance but also exert a lasting influence in the fight against climate change.

4.3.3. Technological Innovation and Digitalization

Technological innovation and digitalization play a key role in climate transition, offering solutions that not only mitigate carbon emissions but also increase the operational efficiency of companies. The existing literature highlights that organizations that prioritize the cultivation and implementation of sustainable technologies can not only comply with regulatory mandates but also take advantage of new market opportunities, thus establishing themselves as pioneers in their respective sectors [20,23].

A primary area of research concerns the influence of socio-technical dynamics on the adoption of sustainable innovations. As articulated by [18], corporations should examine how pre-existing social and technical structures affect the implementation of sustainable practices and develop effective strategies to navigate these environments skillfully. This methodology is particularly important in sectors where cultural or structural impediments may prevent the assimilation of new technologies.

Eco-innovation is widely recognized as a critical practice for facilitating climate transition. Ref. [13] emphasizes the impactful role of Tesla in instigating transformations in the automotive industry, advocating electric vehicles as sustainable alternatives that not only reduce emissions but also reshape consumer expectations. In addition, the incorporation of climate-related opportunities into corporate strategies, exemplified by ABB, illustrates the beneficial influence of innovation on the development of technologies that facilitate the integration of renewable energy sources and reduce CO_2 emissions [14]. Similarly, BYD (China) has emerged as a global leader in the development of electric vehicles and energy storage solutions, significantly expanding low-carbon mobility beyond the Western markets.

The cultivation of an innovative culture in organizations is also recognized as essential to drive climate transition. Ref. [54] argues that encouraging prudent risk-taking initiatives by engineers and corporate leaders can generate substantial improvements in productivity and competitiveness. This innovation-centric culture is enhanced by the importance of entrepreneurship, as highlighted by [52], who advocates the establishment of new business models consistent with a carbon-neutral economy. Another critical dimension is the interaction between regulatory compliance and innovation. Ref. [51] states that corporations that harmonize their operations with regulatory standards while pursuing innovation establish new sustainability standards and position themselves as examples in their sectors. Practical examples include Volkswagen, which, following an emissions scandal, redefined its market position by investing in electric vehicles and adhering to stricter environmental regulations [13]. In Latin America, WEG Industries (Jaraguá do Sul, SC, Brazil) has invested heavily in energy efficiency and electrification technologies, particularly in industrial motors and smart grids, demonstrating that mid-sized companies can also lead in sustainable innovation.

The contributions of green technologies have been widely documented. Wright et al. [23], in turn, indicate that the advancement of sustainable products and technologies, such as Philips' energy efficiency solutions, exemplifies the potential for innovations that mitigate environmental impact and meet the growing demand for sustainable alternatives [15]. Another prominent example is Sungrow (China), a company specializing in inverter technologies and solar energy systems that has played a key role in accelerating renewable integration across Asia and the Global South. In addition, initiatives called "Sustainability Helix" provide guidelines for companies to optimize resource productivity while minimizing their ecological footprints [54].

Ultimately, investment in research and development is identified as a key determinant of promoting climate transition. Ref. [20] elucidates that the development of energy storage solutions and progress in renewable energy technologies is imperative for the transition from conventional energy infrastructures to low-carbon alternatives. In short, technological advancement and digital transformation are essential components for companies that want to lead the climate transition. The integration of investments in sustainable technologies, the promotion of an innovative culture, and the adherence to regulatory mandates allow organizations not only to achieve climate goals but also to excel in an increasingly competitive market.

4.3.4. Energy Efficiency and Renewable Energy

Optimizing energy use and switching to renewable energy sources are critical components of corporate strategies designed to facilitate climate transition. Academic research indicates that these approaches not only lead to a reduction in carbon emissions but also promote competitive advantages through cost reductions and technological advances [16,20]. Companies that allocate resources to clean technologies and energy efficiency initiatives

have shown a favorable influence on their carbon emission profiles and overall financial performance [23].

Decarbonization has emerged as a fundamental practice that is often emphasized in academic discourse. Ref. [53] argues that the reduction of industrial emissions requires the deployment of cleaner technologies, along with a transition to renewable energy alternatives. This methodology not only alleviates environmental repercussions but also allows organizations to maintain competitiveness in a constantly evolving market scenario. Furthermore, Ref. [54] claims that the integration of environmentally sustainable technologies and the refinement of production methodologies have been effective in reducing carbon footprint while increasing operational efficiency.

The shift toward renewable energy sources is widely recognized as a key step in the quest to reduce greenhouse gas emissions. Empirical research reveals that companies like Google and IKEA have successfully achieved 100% renewable energy use in their global operations, serving as role models for other entities [15]. Similarly, Ecopetrol (Bogotá, Colombia) has made significant progress in decarbonizing its operations by investing in energy efficiency programs and incorporating renewables into its extraction and refining processes. In addition, ref. [20] clarifies that organizations adopting renewable energy sources, such as solar and wind, often observe substantial improvements in public perception and compliance with environmental legislation. These initiatives exemplify the clean energy transition's ability to harmonize environmental sustainability with financial gains. In Asia, Tata Steel (Mumbai, Indian) has pioneered the adoption of hydrogen-based steelmaking and implemented advanced waste heat recovery systems, contributing to a reduced carbon intensity in the heavy industry.

Energy efficiency initiatives are widely regarded as effective strategies for organizations aiming to reduce operating costs and emissions. Ref. [23] highlights eco-efficiency initiatives, which are designed to reduce waste and optimize resource use. Similarly, Ref. [15] notes that equipment modernization, process optimization, and the implementation of energy management systems have been validated as effective measures to reduce energy consumption and increase operational efficiency. Additional investigations, such as those conducted by [51], highlight that energy efficiency strategies, in particular improvements in the design and insulation of buildings, generate significant environmental and economic benefits.

Another relevant dimension is the management of energy supply and demand. Ref. [20] postulates that the balance between supply and demand can be achieved through advances in energy efficiency and demand-side management, thus reducing dependence on fossil fuel resources. This strategy is particularly significant for energy-intensive sectors, where innovative solutions can contribute to mitigating the risks related to fluctuating energy prices. Collaboration between stakeholders is another critical factor identified in the literature. Ref. [28] highlights that co-creation and partnerships based on trust between companies, governments, and communities can accelerate the transition to a more sustainable energy future.

In addition, the integration of regional climate information into decision-making processes helps companies adapt their strategies to the specific conditions of each region, increasing the effectiveness of their initiatives [28]. Finally, examples from companies such as DuPont (Willmington, DE, USA) and Alcoa illustrate (Midtown Manhattan, NY, USA) how investments in technological innovation and process improvement can result in significant emission reductions. Likewise, LONGi Green Energy (Xi'an, China), a global leader in solar technology, continues to drive innovation and cost reduction in the photovoltaic sector, enabling wider access to renewable energy worldwide. Ref. [21] highlights that these examples serve as references for other organizations seeking to balance

environmental and economic demands. The combination of renewable energy transition, energy efficiency measures, and multi-sector collaboration emerges as an effective model for companies that want to lead the climate transition.

In summary, energy efficiency and the transition to renewable energy are key components of a successful corporate climate strategy. By combining investments in clean technologies, collaborating with stakeholders, and implementing innovative energy management measures, companies can not only meet environmental targets but also create competitive advantages in global markets.

4.3.5. Stakeholder Engagement and Value Chain

Stakeholder engagement and value chain management are key components of the successful implementation of climate transition strategies in organizations. The existing literature indicates that collaborative alliances and an integrated methodology can substantially increase the results of climate-related initiatives, promoting innovation, cultivating community support, and ensuring equitable distribution of the benefits derived from transitions [17,54].

A central theme explored in the literature is the imperative of actively involving stakeholders and shareholders. Ref. [54] states that an effective climate transition requires the synchronization of all stakeholders with an organization's sustainability goals. This alignment can be accomplished by effectively illustrating the prospective advantages of sustainable practices, such as reducing operating expenses and improving corporate reputation. This perspective is further supported by [16], who highlights the importance of establishing political and community support networks to disrupt high-carbon development trajectories and ensure that transition processes are inclusive and equitable.

Sustainability in supply chains is another widely discussed topic. Refs. [16,51] state that organizations can significantly reduce their environmental footprint by reassessing and optimizing their value chains. This process includes the selection of sustainable materials, minimizing emissions associated with transportation, and promoting ethical delivery methodologies. Unilever is cited as a notable example, having set ambitious emission reduction targets and actively engaged suppliers in adopting more sustainable practices [15]. These initiatives not only enhance corporate sustainability but also align with the growing consumer demand for environmentally friendly products. In India, Marico has worked closely with rural communities to improve agricultural practices, reduce water use, and co-create localized sustainability programs with suppliers.

Intersectoral collaboration is emphasized as an effective strategy for addressing climate-related challenges. Refs. [20,51] highlights the critical importance of involving a diverse range of stakeholders, namely, scientists, engineers, regulators, policymakers, and business leaders, in multidisciplinary collaborative efforts. These partnerships facilitate the exchange of resources and knowledge, culminating in innovative solutions that provide benefits to all participating entities. BASF has developed inclusive engagement models in Brazil and sub-Saharan Africa, co-designing regenerative practices with smallholder farmers to embed sustainability into the agricultural value chain. This collaborative approach is exemplified by the establishment of public standards for sustainable products, as articulated by [53], which promote competitive advantages for companies that adhere to them.

The roles of political support and community engagement are also widely recognized. Ref. [16] notes that companies working with governments, NGOs, and local communities have a greater capacity to promote effective climate initiatives. This collaboration is critical to ensuring that climate transitions not only meet environmental goals but also contribute to social and economic development. The literature also highlights examples

of corporate success in terms of stakeholder engagement and value chain management. Companies like Unilever and initiatives such as public standards for green products illustrate how the integration of sustainable practices at all levels of operation can generate both environmental and economic benefits [16,53]. These cases exemplify the importance of effective engagement in ensuring the success of climate transition initiatives. In addition, regional coalitions across Africa involving governments, private sector actors, and NGOs have emerged as important governance tools for inclusive transition pathways.

In summary, stakeholder engagement and sustainable value chain management are indispensable components for companies seeking to lead in the climate transition. By combining cross-sector collaborations, policy support, and supply chain optimization, organizations can not only achieve their climate goals but also create a positive impact on a global scale.

4.3.6. Economic Benefits and Competitiveness

The transition of corporate climates is not only a reaction to global environmental imperatives but also represents a substantial opportunity for companies to take advantage of competitive advantages and generate economic value. The academic literature highlights that effective implementation of sustainable practices can result in cost reductions, open new market paths, and improve corporate reputation while contributing to the global decarbonization process [17,19].

One of the most widely discussed methodologies is the implementation of sustainable economic practices. Ref. [18] argues that identifying economically viable solutions is crucial for overcoming financial impediments and facilitating broader access to sustainability for a larger cohort of companies. In addition, Ref. [54] emphasizes that the advancement of eco-efficiency practices, focused on continuous improvement, allows companies to adapt to changing market demands, preserving their competitive advantage. Climate transition reveals even more substantial prospects for innovation and the development of new business models. Ref. [21] states that climate policies can reinvigorate the creation of sustainable products and services, meet the growing demand for environmental solutions, and provide a competitive advantage in the market. Ref. [53] amplifies this discourse by observing that the adoption of environmentally sound production methodologies allows companies to access new segments of consumers who prioritize sustainability.

Another relevant consideration is the favorable financial ramifications associated with sustainable practices. Ref. [54] indicates that the execution of decarbonization strategies often culminates in cost reductions and improvements in brand reputation. Similarly, Ref. [51] notes that while climate transition requires substantial initial investments, the long-term benefits, which include consumer loyalty and adherence to regulatory frameworks, significantly outweigh the associated costs. The circular economy is recognized as one of the most effective strategies for reconciling environmental and economic benefits. Ref. [15] states that practices such as recycling, reuse, and waste minimization not only conserve resources but also reduce operational expenses. These initiatives are exemplified by IKEA, which has implemented strategies to reduce its carbon footprint through improvements in energy efficiency and the use of renewable energy sources [15]. Equally illustrative is the case of Infosys (Bangalore, India), which became one of the first global companies to achieve carbon neutrality through a combination of energy efficiency programs, solar energy investments, and internal carbon pricing.

In addition, investment diversification is advocated as the best practice to mitigate transition risks and optimize opportunities. Ref. [12] states that the dispersion of investments in adaptation and mitigation initiatives not only leads to a gradual reduction in emissions but also strategically positions companies to capitalize on regulatory incentives

and avoid the risks associated with carbon pricing. Academic discourse also emphasizes the social advantages of climate transition. Ref. [16] highlights that the creation of jobs in green sectors and retraining initiatives for workers affected by the transition promotes economic and social resilience. These practices not only alleviate the adverse effects of the transition but also increase its acceptance among stakeholders. An example of this is the initiative by Suzano (Brazil), which links reforestation and low-carbon cellulose production with community-based training programs, enhancing regional resilience while creating value.

Specific examples have also been cited in the literature to illustrate the relationship between sustainability and competitiveness. Tesla, for example, revolutionized the automotive industry by introducing electric vehicles that significantly reduced emissions in the transportation sector while creating new market opportunities [13]. Similarly, Ref. [20] highlights the positive impact of adopting hybrid and electric transport, which meets both environmental goals and consumer demands for sustainable products. Likewise, NIO (China) has gained international prominence by combining battery-swapping infrastructure with innovative service models, offering convenience, performance, and sustainability to a growing market in Asia.

Additionally, initiatives, particularly the "Profiting in a Carbon Constrained World Report" provide evidence of how the carbon credit market, exemplified by the Chicago Climate Exchange and the European Climate Exchange, can offer significant opportunities for companies aligned with the demands of a low-carbon market [54]. In Southeast Asia, Singapore's Climate Impact X platform is another emerging carbon marketplace designed to promote transparency and scalability in voluntary carbon trading, opening doors for companies in emerging economies to participate. Finally, the regional impact of climate transition has been widely discussed. Ref. [52] identifies how regions in industrial transition can become more competitive and resilient by taking advantage of opportunities from globalization, decarbonization, and technological advances while minimizing costs for the affected communities.

In conclusion, economic benefits and competitiveness are central components of an effective climate transition. By adopting sustainable practices that promote innovation, cost reduction, and investment diversification, companies can not only achieve environmental goals but also excel in a changing global market.

4.3.7. Social and Just Transition

Social justice and fair transition are key components of the effective implementation of climate transition plans, as they ensure that the benefits and costs of climate action are distributed equitably. The academic literature emphasizes that integrating equity principles and social considerations into climate strategies not only promotes sustainability but also strengthens the acceptance and legitimacy of initiatives [1,17].

A holistic approach to sustainability should consider impacts not directly related to climate, such as social and environmental factors. Ref. [1] stresses that ensuring that climate actions do not cause unintended harm is essential to promoting overall sustainability. In addition, incorporating aspects of a just transition is critical to ensuring that vulnerable groups, particularly local communities, and workers in transitional sectors, are protected and supported during the process. According to [16], involving stakeholders at all stages of planning and implementation is an effective strategy for ensuring equitable results. An illustrative case is South Africa's Just Energy Transition Partnership (JETP), which coordinates efforts between the government, local communities, and international donors to ensure that the phase-out of coal protects workers and stimulates green job creation.

Building resilient infrastructure and promoting sustainable industrialization are also highlighted as essential practices. Ref. [53] argues that the transition from traditional, resource- and pollution-intensive production methods to more sustainable practices not only contributes to climate mitigation but also strengthens the capacity of communities to face the impacts of climate change. This perspective is aligned with the need for sustainable management of natural resources, which involves reducing the use of resources and innovation in the recycling and reuse of materials [54]. Natura & Co (Sao Paulo, SP, Brazil) has implemented inclusive programs with extractive communities in the Amazon region, integrating biodiversity conservation, fair income distribution, and cultural preservation.

Adopting a sustainable development perspective is a recurring theme in the literature. Ref. [20] highlights that companies must integrate environmental considerations into their business strategies and decision-making processes to ensure that economic growth does not occur at the expense of environmental health. This integration is essential for aligning business goals with the global demand for sustainability. The issue of transitional justice is particularly relevant when considering the impact of climate change on vulnerable populations. Ref. [16] argues that protecting at-risk communities, low-income countries, and future generations is essential to achieving a just transition. In addition, addressing the social and environmental challenges associated with the transition, such as changes in energy production, food, and land use, is essential to ensure that corporate practices are sustainable and responsible [16]. In India, ITC Limited has incorporated sustainable agriculture programs that reduce emissions while supporting smallholder farmers through capacity-building and inclusive procurement practices.

Ethical business practices also play a crucial role in climate transition. Ref. [17] highlights that respecting labor rights and promoting environmental justice contribute to improving corporate reputation and building trust with stakeholders. These practices also strengthen the foundation for a just transition by aligning business goals with social and environmental demands. Examples of success have also been widely discussed. Case studies, in particular those highlighted by [53], show how companies in different sectors have implemented sustainable technologies and practices to reduce their carbon footprints and improve their competitiveness. Patagonia is often cited as an example of excellence in integrating sustainability and social justice, investing in renewable energy, supporting environmental causes, and implementing circular economy practices to minimize its environmental impact [15]. Likewise, Safaricom PLC (Nairobi, Kenya) has been recognized for integrating climate resilience into its digital infrastructure while providing rural connectivity, financial inclusion, and community empowerment.

In short, social justice and just transition are indispensable elements of a successful climate transition. Integrating social and environmental considerations, promoting ethical practices, and adopting a holistic approach to sustainability not only ensures equitable outcomes but also strengthens the resilience and legitimacy of climate action. Case studies and corporate examples highlight the transformative potential of such practices, serving as guides for organizations committed to climate transition.

4.3.8. Investments in Nature-Based Solutions

Nature-based solutions (NBS) have emerged as a strategic approach to mitigate the impact of climate change and promote corporate sustainability. These solutions involve the integration of ecological principles into business strategies to manage natural resources, reduce carbon emissions, and create environmental and economic value. The academic literature highlights the growing relevance of these practices as indispensable components of corporate climate transition [14,16].

Natural capital management is one of the central aspects of nature-based solutions. Ref. [13] emphasizes that companies are increasingly aware of the importance of integrating natural capital considerations into their business strategies. This includes recognizing the value of ecosystems and natural resources, such as forests, water, and soil, not only as economic assets but also as essential elements for long-term sustainability. By adopting this approach, companies can mitigate risks related to resource scarcity and environmental costs by aligning their operations with the principles of ecological responsibility. In Peru, the beverage company AJE Group has implemented watershed protection and forest conservation initiatives in the Amazon Basin, aligning biodiversity goals with water security and supply chain resilience.

The concept of "carbon offsetting" (carbon offsetting) is another widely discussed practice in the literature. Ref. [15] argues that offsetting emissions through projects such as reforestation, mangrove restoration (Maranhao, Brazil), or investments in renewable energy offers a valuable tool for companies seeking to neutralize their carbon footprints. While it does not replace the need for direct emission reductions, offsetting plays an important complementary role in enabling organizations to achieve climate goals more comprehensively. This practice also helps promote environmental conservation and restoration initiatives, extending the benefits of climate action beyond the organizational boundaries. Kenya's Green Belt Movement (Nairobi, Kenya), supported by corporate partners, is a notable initiative in this area, having planted over 50 million trees while empowering women and promoting land restoration.

Successful examples of investments in nature-based solutions are widely cited as models of good practices for other organizations. Case studies of companies that have adopted natural capital initiatives or carbon offset projects demonstrate how these practices can simultaneously generate economic and environmental value. Suzano (Salvador, Brazil), a global leader in the bioeconomy, integrates large-scale native forest preservation with sustainable pulp production, representing a robust case of private sector commitment to nature-positive models. Although the specific details of the examples have not been included in this review, the literature highlights that such initiatives often result in significant emission reductions, improvement of corporate reputation, and strengthening of stakeholder relations.

In short, investments in nature-based solutions represent a promising strategy for companies seeking to lead climate transition. In light of the examples presented, when by integrating natural capital management into their business strategies and adopting practices such as reforestation, ecosystem restoration, and biodiversity conservation, organizations can not only mitigate their environmental impacts but also create economic value and strengthen their position in a market increasingly oriented toward sustainability.

4.3.9. Other Good Practices Not Classified

Business practices related to climate transition often transcend conventional categorizations, including interventions that combine policy, regulation, innovation, and the circular economy. These best practices offer comprehensive solutions that address both environmental and economic challenges, positioning companies to lead in an increasingly sustainability-oriented market [1,51].

Political and technological interventions stand out as essential components for climate transition. Ref. [53] emphasizes that the implementation of policies that encourage sustainable practices, combined with investments in clean technologies, allows industries to maintain their competitiveness while adopting greener production methods. This point is complemented by [51], who highlights the critical role of effective regulations as incentives for renewable energy adoption and penalties for high emissions as catalysts for corporate

innovation. The concept of a circular economy is widely recognized as a key approach to minimizing environmental impact and maximizing resource use. Ref. [13] argues that companies should adopt circular economy principles, for instance, by designing products for durability, reuse, and recyclability. This approach is strengthened by the study of [20], which highlights how the implementation of waste treatment and recycling of materials can lead to resource conservation, cost reduction, and the creation of new business opportunities. A compelling case is Grupo Bimbo (Mexico City, Mexico), which has adopted circularity in packaging and logistics, including electric vehicle fleets and biodegradable materials, thereby reducing emissions and creating closed-loop systems.

Innovation is another pillar of best practices, not classified, with studies highlighting the development of products and solutions that meet the demands of sustainability. Ref. [14] cites the example of Philips, which developed the innovative Philips Woodstove, a stove that significantly reduces emissions and energy consumption, improving the quality of life in poorer regions. Similarly, Shell has invested in alternative energy sources and set ambitious emission reduction targets, consolidating its position as a leader in sustainable energy solutions [21]. In contrast, Yoma Micro Power (Yangon, Myanmar) illustrates innovation at the base of the pyramid by deploying off-grid solar microgrids in remote villages and integrating climate action with access to energy and inclusive development.

The evolution of corporate environmentalism also deserves to be highlighted. Ref. [13] notes that while in the past companies focused on complying with environmental regulations, today they adopt more comprehensive strategies, particularly pollution prevention and total quality environmental management. This evolution reflects a deeper understanding of the intersection between business activities and environmental protection, positioning sustainability as a strategic component.

The literature also emphasizes the need to develop skills and prepare the workforce for future challenges. Ref. [52] highlights that the requalification of workers in key sectors is essential to mitigate the social impacts of industrial transition. In Indonesia, the Tropical Forest Alliance has worked with palm oil producers and local governments to retrain smallholder farmers in sustainable land-use practices, merging environmental goals with rural livelihoods. In addition, the development of more effective policies based on cross-cutting lessons is identified as a key strategy for ensuring that transitions are successful in different contexts. Specific examples illustrate the positive impacts of such practices. Whirlpool, for example, has integrated climate solutions into its manufacturing processes, while Swiss Re has implemented comprehensive climate strategies that include risk assessment related to climate change [21]. It is also worth noting the case of BRF (Brazil), which has incorporated biogas generation from organic waste into its food production chain, creating economic and environmental value in a sector often neglected in climate debates. These initiatives demonstrate how companies from different sectors can lead climate transition.

In summary, unclassified good practices are important for promoting corporate sustainability and environmental sustainability. The combination of policy interventions, technological innovation, circular economy principles, and skills development provides a comprehensive roadmap for companies seeking to lead the climate transition.

The list of identified best practices has been classified and is available in Supplementary S1 of the Supplementary Document.

4.4. Implications and Recommendations

The discussions in this study provide a structured synthesis that may inform future research and support corporate and regulatory decision-making regarding climate transition strategies. By consolidating the barriers, opportunities, and best practices associated with corporate climate transition, this work offers a comprehensive framework that not only

contributes to the academic literature but also provides practical guidance to companies and policymakers seeking to align their strategies with global climate goals.

Theoretically, this study advances the literature by integrating three central dimensions—barriers, opportunities, and best practices— from a unified perspective. Previous studies have often analyzed these elements in isolation, leaving gaps in understanding their interconnections and systemic implications. For example, while [6] explores technological incompatibility as a significant barrier, Ref. [18] highlights the lack of appropriate tools for developing low-carbon products. By organizing these elements within a single framework, this study contributes to a clearer and more structured view of the key dimensions of corporate climate transition.

Another significant theoretical contribution is the identification of gaps in the literature that require further research. For example, the insufficient academic exploration of how preschool cultural and organizational concepts impact the adoption of sustainable technologies suggests the need for future studies to investigate the interactions between cultural resistance and the implementation of climate innovations. While there is a growing body of literature addressing carbon pricing, research specifically focused on its implications for the transition strategies of small and medium-sized enterprises (SMEs) remains limited, particularly in emerging economies and in sectoral comparative contexts.

From a practical point of view, the implications are equally broad. Indeed, corporate climate transition requires a coordinated approach among different actors, notably public policymakers, governments, companies, regulators, and other stakeholders. In this context, a set of recommendations based on the barriers, opportunities, and best practices analyzed throughout this study is presented. These recommendations are oriented toward promoting an effective and inclusive transition to a low-carbon economy. First, public policymakers and governments should prioritize the creation of clear and predictable regulatory environments. The lack of consistency in regulatory frameworks is a factor that discourages investment in low-carbon technologies, as highlighted by [5,7]. Therefore, it is essential to develop tools such as carbon pricing, clean technology subsidies, and tax incentives that not only promote the competitiveness of sustainable companies but also ensure a fair transition for vulnerable sectors.

In addition, governments are recommended to increase investment in infrastructure and research to enable climate transition. Studies, such as those by [2], show that a lack of infrastructure is a critical barrier, especially in emerging markets. Therefore, public-private partnerships are needed to foster the implementation of technological solutions, such as renewable energy networks and carbon storage technologies. In addition, it is essential that governments lead by example, adopt sustainable practices in public operations, and promote awareness campaigns to broaden social engagement in climate transition.

For companies, it is recommended to integrate climate transition strategies into their business models. As pointed out by [1,10], the lack of integration of climate goals with corporate operations compromises the effectiveness of such sustainability initiatives. Therefore, companies should develop transition plans that include clear and measurable goals, as well as transparent environmental performance reports aligned with frameworks, namely the International Sustainability Standards Board (ISSB) and the Task Force on Climate-related Financial Disclosures (TCFD). In addition, the adoption of nature-based solutions and the incorporation of circular economy principles can significantly enhance the positive impact of business actions.

Regulators and regulatory bodies play key roles in harmonizing standards and promoting corporate transparency. Ref. [28] highlights that the lack of standardization in climate metrics generates inconsistencies in sustainability reports, making comparisons between companies and sectors difficult. While relevant initiatives—notably the EU Taxonomy,

GRI, and ISSB standards—have advanced the harmonization of climate-related disclosures, further efforts are needed to ensure global interoperability and adoption across diverse regulatory and sectoral contexts. It is also relevant that regulators encourage the creation of more robust carbon markets and ensure monitoring and verification mechanisms to avoid greenwashing.

Finally, it is essential to engage all relevant stakeholders, including local communities, non-governmental organizations, and academic institutions. The study by [17] highlights that integrating diverse perspectives improves the social acceptance of climate initiatives and increases their chances of success. In this context, it is recommended that dialogue platforms be established to allow the active participation of these actors in the formulation and implementation of transition strategies. Overall, the recommendations aim to align global and local efforts to overcome barriers, capitalize on opportunities, and disseminate best practices for corporate climate transition. Collaboration between different sectors and the adoption of coordinated measures are indispensable for moving toward a low-carbon economy while promoting environmental, economic, and social benefits.

4.5. Trajectory and Suggestions for Future Research

In recent decades, research on corporate climate transition plans has evolved significantly, reflecting the growing global urgency to address climate change and its economic, social, and environmental implications. Initially, the studies focused on understanding the specific barriers faced by companies, notably financial, technological, and regulatory challenges, emphasizing the lack of adequate infrastructure and difficulty in accessing sustainable financial instruments [1,9]. These studies aimed to map the factors that prevented the adoption of sustainable practices, with the aim of identifying specific and contextual solutions.

As research has progressed, the focus has expanded to explore opportunities arising from climate transition, particularly in technological innovation and climate governance. Studies by [14,23] highlighted the role of innovation in catalyzing transformations in the industry, promoting solutions such as electric vehicles and renewable energy sources. In addition, the integration of fair transition principles into business strategies has emerged as a central theme, emphasizing the need to ensure that the benefits of climate change are widely distributed among affected communities [17]. It is important to highlight that many studies prioritize the analysis of barriers or opportunities in isolation without integrating these two dimensions into a broader theoretical framework. As discussed by [7], the intersection between regulatory barriers and technological opportunities represents a promising area of research that still lacks systematic approaches. Thus, it is essential to investigate how these challenges can be simultaneously overcome and converted into effective climate transition levers.

Another aspect that deserves attention is the scarcity of longitudinal studies capable of capturing the temporal dynamics of corporate climate initiatives. Current research tends to adopt cross-sectional methodologies that offer a momentary portrait but fail to explore how companies adapt their climate strategies over time in response to technological, regulatory, and market changes. In this context, the studies of [3,23] suggest that analyses integrating time series data could provide more robust findings on the determinants of success and failure in climate transition. Simultaneously, the literature on best corporate practices gained space, consolidating case studies that serve as references for other organizations. Examples from Google and IKEA demonstrate how companies can adopt 100% renewable energy and optimize their value chains, significantly reducing their carbon emissions [16,20]. These cases also stimulated the adoption of instruments, such as green

bonds and sustainability-linked loans, showing that it is possible to align sustainability with profitability [12].

The trajectory of this research also reflects a movement toward an integrated understanding of barriers, opportunities, and practices. While the first studies treated these aspects in isolation, more recent works seek (or at least should) to systematize and interconnect these dimensions. This approach allows for an understanding of the interrelations between regulatory, technological, and cultural factors, promoting more comprehensive and effective solutions [7,28].

It is also observed that the frontier of knowledge on this subject moves toward the integration of big data and predictive analysis to improve climate risk management and the operational efficiency of companies. Emerging studies emphasize the use of digital tools to monitor climate indicators in real-time, promoting more agile and informed decision-making [18]. In addition, the advancement of international frameworks, namely the Science-Based Targets Initiative (SBTi), stands out as a driver for the standardization of corporate climate goals, ensuring greater transparency and accountability (Tilsted et al., 2023) [30]. Another promising aspect is the increasing emphasis on nature-based solutions that promote biodiversity conservation while mitigating climate impacts. Ref. [13] study highlights how natural capital initiatives and carbon offset projects are being integrated into broader corporate strategies, offering both ecological and financial benefits simultaneously.

In summary, the evolution of research on corporate climate transition demonstrates a trajectory of increasing complexity and sophistication, with advances that connect barriers, opportunities, and practices. The frontier of knowledge points to an even greater integration between technological innovation, climate governance, and social justice, providing a robust framework for future initiatives in the global context of climate urgency. The identified gaps highlight the need for research that integrates interdisciplinary approaches, focuses on poorly explored contexts, and develops more robust methodological tools. Advancing in these directions will not only enhance the academic understanding of corporate climate transition but also contribute to the development of more effective and inclusive policies and practices.

5. Conclusions

Corporate climate transition is a multifaceted process that requires coordinated action among governments, companies, financial actors, and civil society. The analyses carried out throughout this study show that barriers, opportunities, and best practices for the effective implementation of corporate climate transition plans are interdependent and require integrated solutions.

In general, the barriers identified are diverse and cover financial, regulatory, organizational, technological, social, and data aspects. First, financial barriers, such as high initial investment costs and uncertainty about financial returns, significantly limit companies' progress toward decarbonization [2,12]. Inconsistent regulations and gaps in standards also create challenges that make corporate decision-making difficult, generating volatility and insecurity [7]. In turn, technological barriers, in particular, the incompatibility between existing infrastructure and new low-carbon technologies, highlight the need for investments in innovation and cross-sector collaboration [19,34]. These barriers, when added to cultural resistance and the lack of effective stakeholder engagement, highlight the complexity of the organizational and social contexts of climate transition [4,9].

Conversely, the opportunities offered by climate transition are equally significant and include sustainable investments, technological innovations, competitive gains, and alignment with global sustainability demands. The development of financial instruments, such as green bonds and sustainability-linked loans, and the increasing adoption of clean

technologies have boosted access to new markets and promoted greater business resilience [11,44]. In addition, technological innovation, when integrated with digitalization and the circular economy, has proven to be a transformative factor in creating effective and long-term solutions [13,19]. At the same time, it is observed that companies that integrate the principles of a fair transition into their strategies can increase the support of stakeholders and promote social inclusion, thereby reducing resistance to structural changes [17].

The best practices and successful examples analyzed reinforce the relevance of robust climate governance and effective engagement with stakeholders. Companies such as Google, IKEA, and Unilever illustrate the importance of clear sustainability targets, renewable energy investments, and collaborative partnerships to promote sustainable value chains [14,16]. In addition, initiatives, particularly the use of nature-based solutions, namely forest restoration and carbon offset projects, not only help to mitigate environmental impacts but also strengthen stakeholder relations and enhance corporate reputation [14,28]. However, it is essential that such practices are accompanied by transparency and accountability to avoid greenwashing practices and ensure credibility with investors and society in general [1,15].

This review not only consolidates the central dimensions of corporate climate transition but also offers actionable insights for financial institutions, which can develop better-aligned instruments and services; for policymakers, who can improve legal frameworks to remove structural bottlenecks; and for business leaders, who can refine transition strategies, engage stakeholders, and unlock sustainable value. By bridging empirical evidence and practical application, this study provides an integrated resource for academics, decision-makers, and corporate practitioners committed to accelerating the transition to a low-carbon global economy.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/cli13050088/s1: Section S1: Classification of Barriers into Categories; Section S2: Classification of Opportunities into Categories; Section S3: Classification of Best Practices and Successful Examples into Categories.

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