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Corporate Competitiveness Index of Climate Change: A Balanced Scorecard Approach

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Received: 30 January 2019; Accepted: 5 March 2019; Published: 8 March 2019



Abstract: Climate change is one of the most critical issues in the business sector. This conceptual study proposes a corporate competitiveness evaluation model of climate change by adopting the Balanced Scorecard approach. This study provides a series of specific performance and competitiveness indicators of climate change in the four dimensions of learning and growth, internal process, external stakeholders, and finance and carbon performance. The indicators, which use both quantitative and qualitative methods, can be immediately applied in the field. This study presents practical guidelines to successfully adopt and implement the competitiveness evaluation model in an organization by considering prevalent innovation tools of business process management, process visualization, and knowledge socialization. Finally, it provides some implications for managers and policy-makers who wish to proactively address climate change in the business sector.

Keywords: corporate competitiveness; climate change; Balanced Scorecard; performance evaluation; indicators; conceptual study

1. Introduction

Climate change has emerged as one of the most critical political, economic, and social challenges of the 21st century. Global warming is an economic risk factor projected to account for 15% of the world's total GDP by 2050, as well as a physical risk factor expected to extinguish 20–30% of biological diversity [1,2]. The Paris Agreement, signed in 2015, has accelerated the transition into a low-carbon economy. One hundred eighty-nine countries across the globe have agreed to cooperate in limiting the rise of the global temperature to well below 2 °C. Countries have publicly announced their commitment to implement the Intended Nationally Determined Contribution (INDC). For example, the major countries of the European Union declared a national goal of reducing greenhouse gas emissions by more than 80% by 2050.

Climate change may not only alter the way individuals work and live but may also reshape value chains, ultimately causing a radical change in business management [3]. Firms' response to climate change has increasingly influenced their competitiveness and performance because they are vulnerable to the direct physical impacts of climate change and they also face the increasing expectations of various stakeholders, such as governments, financial institutions, consumers, and local communities for corporate policies, plans, and programs, in addition to appropriate measures to tackle climate change [4]. Some leading companies, such as Pacific Gas and Electric (PG and E), Ford Motor

Company, and DuPont have responded preemptively, urging the U.S. government to establish strong regulatory measures to counter climate change [5,6]. Proactive approaches have included developing low-carbon products, improving process efficiency, collaborating with supply chain partners to reduce emissions from the entire supply chain, and creating new market and business opportunities [7,8]. They may also invest in clean mechanism development (CDM) projects to acquire a certified emission reduction (CER) and disclose carbon information requested by external stakeholders (e.g., the Carbon Disclosure Project).

However, there is a lack of academic and practical focus on the corporate competitiveness of climate change. First, climate change has emerged as a critical market and a competitive issue that extends beyond environmental, policy, and political issues [9]. Research on climate change from a corporate competitiveness perspective, however, is still in an early stage. Few studies have paid attention to developing an evaluation system that can consistently monitor, track, and observe corporate competitiveness regarding climate change. The literature related to the intersection of climate change and competitiveness has focused more on performing measurements on an aggregated national or industry level [10,11] instead of within individual firms [12]. Although some efforts have been made to evaluate the corporate competitiveness of climate change, such as those evinced by the Global Reporting Initiative (GRI) and Climate Counts, there is still an urgent need for the development of an evaluation scheme and index that could evaluate and analyze corporate responses to climate change from the perspective of competitiveness.

Second, the relationship between firms' response to climate change and their economic performance remains inconclusive [13,14]. Recently, a few studies examined the organizational financial performance of carbon management. For example, Wang et al. [15] investigated the relationship between greenhouse gas emissions and Tobin's Q, and Kim et al. [16] analyzed the impact of carbon risk management on the cost of capital. A growing number of arguments assert that corporate competitiveness regarding climate change is a multi-dimensional construct, and encompasses leadership and internal management practices at minimum, in addition to those related to the environment, energy, and financial performance. As such, an assessment of corporate competitiveness should cover a broader range of aspects beyond financial outcomes to ensure the comprehensive consideration of other capabilities.

Given this gap in the literature, the present study aims to develop a corporate competitiveness evaluation model of climate change, including index and measurement scales, that is capable of simultaneously assessing firms' non-financial and capability-based performance and their financial and outcome-oriented performance. The model's objective is to provide a rationale for the validity of employing the concept of balanced scorecard (BSC) to measure and evaluate a firm's climate change competitiveness from internal and external aspects as well as short and long-term perspectives. This conceptual study presents a framework to help companies monitor and evaluate the current level of corporate climate change competitiveness and thereby seek opportunities for continuous improvements. This model comprises a preliminary source of reference to provide a plausible causal relationship between climate change competitiveness and financial performance. The indices suggested in this study can be elaborated in the development of measurement scales used in empirical studies.

The rest of this paper is organized as follows. Section 2 explores the theoretical background of corporate climate change competitiveness, the indexes, and the BSC. Section 3 describes the research method, and Section 4 proposes a conceptual framework for an evaluation system of balanced climate change competitiveness. Section 5 discusses the practical applications and implications of the system, and Section 6 provides a summary of the study, its limitations, and future research directions.

2. Theoretical Background and Literature Review

2.1. Climate Change Competitiveness

Competitiveness is generally understood as a function of a firm's core competencies and its ability to perform these capabilities [17,18]. Currently, there is interest in developing a quantified index for evaluating corporate competitiveness that has practical applications. For decades, productivity, which is rooted in microeconomics, has been widely utilized as the core index for measuring corporate competitiveness, as it is believed to closely reflect low cost and high market shares [17]. However, scholars have claimed that non-monetary factors should be included to better understand corporate competitiveness through the indices with which it is measured. For example, Kay [19] introduced innovation, internal and external core relationships, reputation, and strategic assets as the four characteristics of an extended concept of corporate competitiveness. Non-financial views concentrate more on tangible and intangible resources as sources of competitive advantage rather than on a single result-based measure of productivity [20]. Corporate competitiveness has become understood as the capability of reflecting the firm's dynamic nature in designing, producing, and marketing products that are superior in both quality and price to those provided by competitors [21].

An evaluation of corporate competitiveness considers not only a firm's internal factors, including strategy development and deployment, but also the external stakeholders' perspectives. Traditional finance and accounting-based indices, such as the return on assets (ROA), are likely to cause external stakeholders to focus on the outcomes of the past. A competitiveness index should not overlook future-oriented performance indicators, such as product quality, consumer satisfaction, employee satisfaction, and innovation activities [22]. For this reason, intellectual capital has been given attention as a crucial performance evaluation criterion in quantifying intangible values. The inclusion of such non-financial measures in a competitiveness evaluation is justifiable because, as intermediaries, they can indicate the ways corporate strategies might be connected to final outputs, such as financial performance.

In the climate change domain, research on competitiveness has focused on conducting measurements at an aggregated industry level, not within individual firms [12]. This is due to the influence of the economics perspective, which has used productivity as a proxy for competitiveness for decades. For example, some literature has examined how climate change affects a company's structure and its average level of business profits [16,23,24]. In exploring the relationship of climate change and industrial competitiveness, much of the literature emphasizes the business risk factors that arise from climate change. Study findings urge business practitioners to observe and prepare for changes in corporate competitiveness engendered by policy risks, such as greenhouse gas reduction regulations, economic risks, such as price increases and changes in market demand, and physical risks, such as natural disasters [9].

Recently, a few studies have examined the effects of climate change on the competitive business environment and corporate performance [8,25]. One stream of the relevant literature focuses on corporate sustainability competitiveness, stemming from the concept of sustainable development, which simultaneously emphasizes societal, environmental, and economic aspects of development. One central concept helping to operationalize sustainability in the business sector is the triple bottom line approach, through which a balanced and minimum performance is achieved in the environmental and social dimensions as well as that of the financial [26]. Garcia and Sanz [27] also propose a triple dimension in their consideration of sustainability and climate change, which includes a diverse range of developments in human capabilities, human rights, and ecology. There is a great need for an approach to define and operationalize competitiveness related to climate change.

2.2. Climate Change Competitiveness Index

Thus far, the competitiveness evaluation systems of climate change that have been developed and applied mainly comprise models and indicators measuring the performance of mitigation

policies or the socio-environmental vulnerability of climate change adaptation areas. The targets of such evaluations are classified at a national or firm level. The Climate Competitiveness Index, which was developed and distributed by AccountAbility, a non-profit organization based in the UK, and the United Nations Environment Programme (UNEP), evaluates a nation's climate change policies. This index has comprehensively measured and disclosed the efforts of 95 countries' towards a low-carbon economy regarding greenhouse gas reduction, the generation of new jobs, technological innovation, and the provision of business opportunities. Although it has served as a monitoring and diagnosis tool for national carbon policies, this index provides a plausible theoretical background for developing corporation-level climate change competitiveness indices because it closely examines the concept of "competitiveness." Meanwhile, the Climate Institute of Australia and E3G (Third Generation Environmentalism) proposed a low-carbon competitiveness index, which was designed to measure 19 different variables at the national level, including the transport-sector energy consumption per capita, deforestation rate, size of the road transport sector, growth in greenhouse gas emission, and carbon intensity of electricity [28,29].

At the corporate level, the guidelines of the Global Reporting Initiative (GRI) have been widely used to measure climate change competitiveness [30]. The GRI is an international non-profit organization that provides standardized guidelines for corporate sustainability reporting. The fourth GRI guideline (G4), the most recent version, details reporting categories related to corporate climate change adaptations and responses. Following the GRI guidelines, a firm's voluntary report of its internal strategy, activities, and data-based performance (e.g., energy consumption and CO₂ emissions) could be used to measure the qualitative and quantitative aspects of its climate change competitiveness.

As the business sector has been highlighted as a critical actor in addressing climate change, various stakeholders (e.g., governments, financial institutions, investors, consumers, non-governmental organizations (NGOs), and local communities) are increasingly expecting adequate information on corporate policies, plans, programs, and measures to tackle climate change and the resultant consequences [4]. For instance, collective action by institutional investors, in conjunction with that of governments, has contributed to the emergence of the Carbon Disclosure Project (CDP). Since its inception in 2002, the CDP has been considered one of the most credible initiatives for carbon information reporting. The CDP requested that more than 5600 companies worldwide disclose information on their strategies, response systems, and performance related to climate change. This includes carbon information, such as emission levels, reduction target goals and investments, and awareness and international governance regarding climate change issues [14]. Climate Counts, a non-profit organization, developed an index that rates business response to climate change in four aspects: contributions to the reduction of global warming, efforts to mitigate climate impact, support for progressive climate legislation, and disclosure of climate protection efforts [31]. In South Korea, the Korea Business Council for Sustainable Development (KBCSD) introduced a climate change competitiveness index that can be used by firms to perform self-assessments. This index consists of five evaluation criteria: climate change risks and performance, market opportunities, cooperation with policy makers, and climate change adaptation; it aims to provide Korean business practitioners with insights to better identify new risk factors caused by climate change, analyze their weak points, and seek opportunities for improvements.

Much of the extant literature and the scholars themselves emphasize the business risk factors arising from climate change. Some organizations and scholars have developed risk management frameworks that companies can use to systematically evaluate and analyze their risk related to climate change. For instance, the ISO 31000 scheme has been adopted by many leading companies worldwide, whereas country-specific climate change risk frameworks are utilized more by individual countries, some examples of which are Climate Change Risk Assessment (the UK), AS/NZS4360 (Australia and New Zealand), and KLIMACHECK (Germany). A recent study proposed a web-based tool for climate change risk management for the business sector [32]. This tool helps companies identify and analyze their climate risks to reduce potentially negative future financial impacts.

2.3. The Balanced Scorecard in Sustainability Issues

Kaplan and Norton [22] proposed the Balanced Scorecard (BSC) by arguing that preexisting performance evaluation systems were generally skewed towards monetary measures, such as revenue and net profits. The BSC consists of four interrelated, but balanced, dimensions of firm performance: financial outputs, customer satisfaction, internal process efficiency, and learning and growth potential. The BSC has been quickly adopted worldwide due to the acknowledgment that it is both a strategic performance management system and a corporate innovation tool. It has also been applied to environment and sustainability management domains. For instance, Epstein [33] and Rejc [34] proposed a BSC-based environmental performance measurement and evaluation system. They argued that strategic environmental management should incorporate quantitative performance measurement and multi-dimensional indices. Some studies have developed sustainability performance evaluation frameworks using the BSC concept, e.g., [35–38]. For example, Figge et al. [35] acknowledged that the BSC is relevant to sustainability because it simultaneously covers environmental, social, and economic performance. Named the sustainable BSC, they proposed a hierarchical and causal model that expresses how environmental and social performance leads to economic performance. In the sustainability management literature, two different approaches have focused on using the BSC to measure corporate sustainability performance. One approach uses environmental and social performance as another independent and non-market dimension of the BSC, differentiated from its extant four aspects. The other approach incorporates environmental and social performance into each of the four perspectives—financial outputs, internal processes, customer satisfaction, and learning and growth. The argument that social and environmental issues should not be treated separately but should, instead, be incorporated into business activities, such as product development, production, supply chains and procurement, marketing, and accounting control, which has gained more support and should, therefore, be interconnected with the traditional processes of managerial decision-making. To this end, the latter approach, which defines environmental and social performance within the four BSC perspectives, has become more prevalent [39]. Collectively, the literature that has employed the BSC in measuring and evaluating a firm's environmental and sustainability performance provides a rationale for the validity of its use in evaluating corporate climate change competitiveness.

3. Research Approach and Method

This study develops a conceptual framework of the corporate competitiveness of climate change based on the concept of the BSC. We synthesized the relevant literature and our understanding to explain how to measure and evaluate corporate competitiveness of climate change from a balanced view, which simultaneously comprises both internal and external aspects as well as short and long-term perspectives. Guided by Jabareen [40], we followed a procedure to build our conceptual framework. First, we specified a research topic within a specialized field of the literature at the intersection between corporate competitiveness, climate change, and the BSC. Second, we comprehensively reviewed relevant and updated research on this theme. Third, we identified the specific dimensions, aspects, and latent variables related to the corporate competitiveness of climate change. In particular, we isolated four scopes of critical variables: learning and growth, internal process, external stakeholders, and performance. Finally, this study generated the conceptual framework by combining the variables from the literature and our understanding. Our detailed explanations served as a reference for constructing this conceptual framework. In effect, our framework attempted to narrow the gap in the literature and address the question regarding the optimal means of approaching the corporate competitiveness of climate change.

4. Research Results: The Balanced Scorecard-based Corporate Competitiveness Evaluation of Climate Change

4.1. Conceptual Framework

This study applies the concept of the BSC to develop a system and indices that measure and evaluate corporate competitiveness concerning firms' efforts in response to climate change issues. Based on the four dimensions of the BSC (i.e., financial outputs, customer satisfaction, internal processes, and learning and growth), this study proposes a corporate competitiveness evaluation system of climate change that can express corporate carbon management practices as qualitative and quantitative values, as shown in Figure 1.

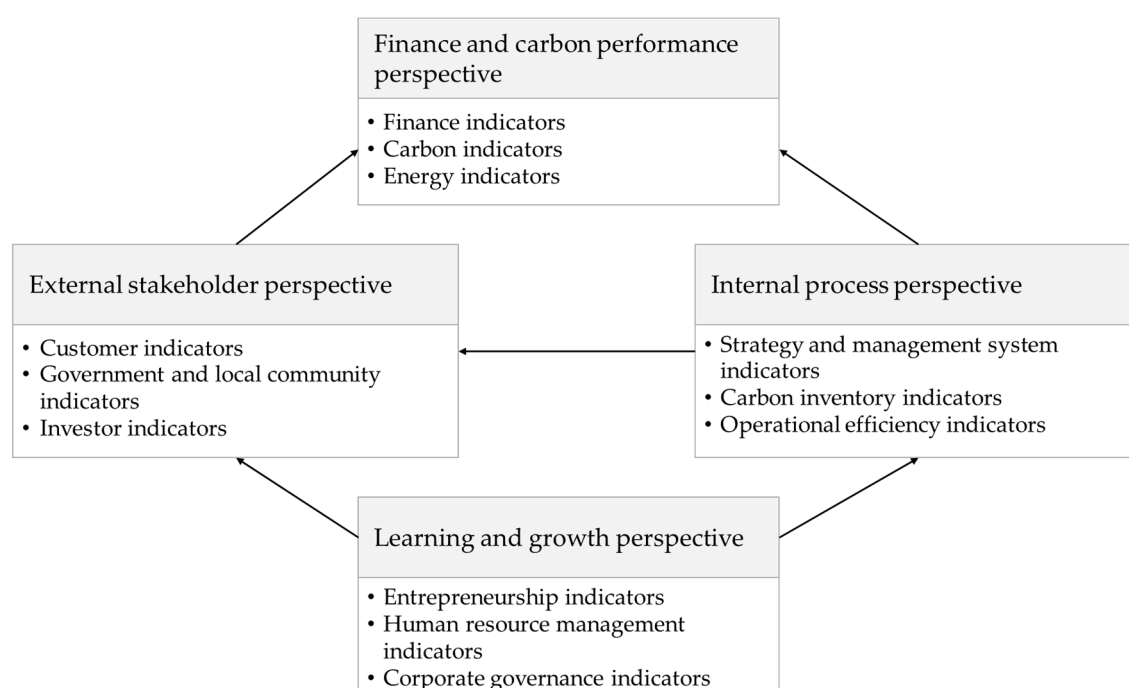


Figure 1. The Balanced Scorecard for corporate competitiveness of climate change.

The learning and growth perspective of climate change competitiveness is the most future-oriented measure of competence in the BSC. Although it is not an area in which significant results are obtained, it reflects the long-term investments and efforts of a firm. The learning and growth perspective emphasizes a firm's collective ability to drive the other three dimensions of performance. This perspective primarily evaluates corporate entrepreneurship to seek opportunities from climate change issues, employee education and training intended to improve climate change competitiveness, and governance, to promote organizational involvement. First, entrepreneurship has been a topic of enormous interest to academics, industries, and governments around the world because it is believed to favor economic growth, employment, and technological and social innovations [41]. It is also of interest for studies focused on the business response to climate change [42]. For instance, Lee and Ahn [43] provide evidence that climate-entrepreneurial proactivity favors a more active approach to tackling climate change issues and facilitates organizational and technological innovation, which in turn leads to operational, market, and emission reduction performance. Second, from the perspective of strategic human resource management, employees are perceived as a strategic element in the organization that facilitates the acquisition and maintenance of competitive benefits and consequently, the achievement of organizational goals. Third, employee involvement plays a significant role in translating strategic goals into daily practices. Researchers have provided evidence of positive linkages among human resource management, the employee relations climate, and operational and financial performance [44].

Collectively, the learning and growth perspective represents intangible organizational assets regarding firms' responses to climate change.

Second, the internal process perspective focuses on the competencies of core management processes within the firm. The BSC emphasizes the efficient operations of internal management processes because it is an essential prerequisite for increasing customer satisfaction in the market and improving financial performance. Climate change accelerates unexpected and abrupt changes in business organizations in terms of assets damage, operational interruption, and increased costs. In such a disruptive era of climate change, businesses should foster their capacity for resilience, which enables firms to withstand, adapt, and quickly recover from stresses and shocks. It is, therefore, critical for businesses to identify climate change-related risks, reduce their vulnerability, and effectively build their resilience [45]. In incorporating climate change issues into a business strategy, firms should ensure that their internal processes are managed systematically, efficiently, and flexibly. Some major indicators of interest in this competitive dimension are management innovation practices for low-carbonizing and resilient internal processes and operations, as well as the establishment and continuous improvement of carbon inventory systems that enable a firm to manage greenhouse gas emissions effectively.

Customer satisfaction as an indicator of market performance comprises one of the four pillars in the BSC system because customers presumably have the most significant impact on achieving high financial performance owing to their clear causal relationship. In the climate change competitiveness framework, we extend the scope of customers to include other external stakeholders, including governments, investors, the local community, and NGOs. Companies are significant contributors to climate change while also being simultaneously exposed to its direct physical impacts. Stakeholders' expectation that firms take more proactive action to tackle climate change has continued and they are demanding more transparent information disclosure to monitor improvements in climate change and financial performance [4,46]. For instance, the CDP has stimulated corporate carbon information disclosure, especially among large corporations, throughout the world. The path dependence theory provides a theoretical foundation to explain how firms' future technological and business success can be affected by the organizational routines and social structure they have accumulated over a long period of time [47]. As a result, in a firm's response to climate change and environmental issues, their establishment of deep and cooperative relationships with such stakeholders prompts the accumulation of social capital, which becomes one of the core corporate capabilities [48].

Finally, the financial performance perspective is generally measured quantitatively and considered extremely important in the business world. This study widens the scope of this performance dimension to include quantitative measures of climate change performance. This perspective includes performance areas that a firm strives to improve through diverse endeavors focused on addressing climate change. In this competitiveness dimension, quantified performance indicators include reductions in carbon emissions and energy consumption, as well as monetary measures, such as returns on assets and net profits. We argue that firms are likely to have two closely interconnected types of motivation when they endeavor to improve their climate change competitiveness: intrinsic and extrinsic. First, firms can have pure motives to contribute towards mitigating climate change (i.e., *intrinsic*). Sustainability requires firms to pursue social and environmental performance beyond financial performance (i.e., the triple bottom line). Moreover, the ethical dimension is also crucial in approaches to sustainability and climate change in the business sector [27]. The ethics of sustainability and climate change must be incorporated into employees' daily life habits; thus, firms should endeavor to enhance the entire organization's awareness and encourage responsible lifestyles to mediate climate change problems. Second, firms can also have instrumental motivations, such as product differentiation, reputation enhancement, and cost reductions, through addressing climate change issues in their management (i.e., *extrinsic*). Quite often such intentions are not distinguishable; therefore, we suggest that both financial and climate change performance indicators should be simultaneously considered in the fourth competitiveness perspective.

4.2. Climate Change Competitiveness Indicators

This section proposes specific indicators that measure and evaluate corporate climate change competitiveness in the four BSC-based perspectives.

4.2.1. Learning and Growth Indicators

The learning and growth perspective evaluates a firm's long-term investments and efforts to improve competitiveness and performance in addressing climate change issues. This perspective focuses on accumulating intangible assets through employees and the entire organization, which are critical antecedents of improving the efficiency of internal process operations, the satisfaction of external stakeholders, and the firm's financial performance. By combining the literature and business cases from leading global companies, this study proposes seven indicators representing climate change competitiveness from the learning and growth perspective in the three sub-categories of entrepreneurship, human resource management, and corporate governance (Table 1). The qualitative self-assessment indicators are listed in Appendix A.

Table 1. Climate change competitiveness indicators from the learning and growth perspective.

Category	Indicator	Measurement
Entrepreneurship	Climate change entrepreneurial proactivity (sensing, monitoring, and integrating)	Self-assessment criteria *
Human resource management	Education and training provided to employees for climate change management	Education/training time per person each year
	Department/Staff exclusively in charge of climate change issues	No. of staff members
	Research and development (R&D) workforce for climate change issues	Research personnel ratio
Corporate governance	Committee in charge of corporate climate change-related management practices	Self-assessment criteria *
	Work-level cooperation for corporate climate change-related management practices	Self-assessment criteria *
	Diversity of committee members	Self-assessment criteria *

* Table A1.

4.2.2. Internal Process Indicators

Responses to climate change must be incorporated into firms' strategies and daily management decision-making processes. At the same time, firms should be equipped with a system that measures and evaluates the impact of climate change issues on their businesses. In the internal process perspective, the competitiveness evaluation encompasses business strategies considering climate change, carbon management integrated with daily management practices, the systematic management of firms' greenhouse gas emissions, and efficient operations for eliminating waste. This study proposes 16 indicators to represent carbon competitiveness in the internal process perspective organized by the three sub-categories of strategy and management systems, carbon inventory, and operational efficiency (Table 2). The indicators can be measured using both qualitative self-assessment and quantitative methods (Appendix A).

Table 2. Climate change competitiveness indicators from the internal process perspective.

Category	Indicator	Measurement
Strategy and management system	Establishment of strategies and management system to address climate change issues	Self-assessment criteria *
	Systematic evaluation of the impact of climate change issues on businesses	Self-assessment criteria *
	Streamlining corporate practices in response to climate change	Self-assessment criteria *
	Projects and initiatives to mitigate climate change	Self-assessment criteria *
	CDM project implementation	Yes or No
	Certification related to climate change	No. of certifications
Carbon inventory	Level of inventory system	Self-assessment criteria *
	Scope of carbon inventory	0%; −24%; −49%; −74%; −100%
	Linkage of carbon inventory and reduction measures	Yes or No
	Carbon sink adopted in the inventory system	Yes or No
Operational	Reduction ratio of waste	%
efficiency	Waste quantity	Ton/year
	Recycling rate	%
	Increase in recycling	%
	Water consumption	Ton/year per person
	Water reuse ratio	%

* Table A2.

4.2.3. External Stakeholders Indicators

A firm's response to climate change affects and is affected by various external stakeholders, including customers. Because the satisfaction of customers is a source of corporate competitiveness, building deep relationships with stakeholders, such as the government, local communities, and investors, plays a critical role in a firm's accumulation of social capital, which in turn leads to higher performance. First, firms are increasingly expected to participate more actively in national and local governments' climate change policy-making processes [9], which allows them to create a favorable regulatory environment for their businesses. Second, financial investors have shown a growing interest in climate change issues, as they realize that climate-change-related risks might undermine their corporate value and investment assets. Firms should respond promptly to investors' increasing requests for information disclosure, exemplified by endeavors such as the Carbon Disclosure Project (CDP). The competitiveness evaluation system of this study provides 12 indicators for the external stakeholder perspective in the three sub-categories of customers, government and the local community, and investors (Table 3). The indicators can be measured using both qualitative self-assessment and quantitative methods (Appendix A).

4.2.4. Finance and Carbon Performance Indicators

This perspective measures carbon and financial performance as the ultimate indicators of corporate climate change competitiveness. We argue that the other three climate change competitiveness dimensions—learning and growth, internal processes, and external stakeholders—substantially contribute to improving firm value and mitigating climate change simultaneously. We provide 12 indicators for financial and carbon performance under the three sub-categories of finance, carbon, and energy (Table 4). All indicators are measured using quantitative methods.

Table 3. Climate change competitiveness indicators from the external stakeholder perspective.

Category	Indicator	Measurement
Customers	Customer satisfaction	Self-assessment criteria *; Firm's own customer satisfaction measurement tool
	Market share	%
Government and local community	Voluntary agreement	Yes or No
	Association with government carbon policies	No. of activities, Yes or No; Self-assessment criteria *
	Participation in government carbon policies	Yes or No; self-assessment criteria *
	Disclosure of carbon information	Yes or No; self-assessment criteria *
	Corporate philanthropy regarding climate change issues	Dollars/year
	Disclosure of reduction goals	Yes or No; self-assessment criteria *
Investors	Disclosure of carbon performance	Yes or No; self-assessment criteria *
	Investments in climate change measures (energy conservation and greenhouse gas technology investments)	Dollars/year
	Ratio of investments in climate change measures (energy conservation and greenhouse gas technology investments)	%
	Carbon fund investments	Dollars
	Response to the CDP request	Yes or No; self-assessment criteria *

* Table A3.

Table 4. Climate change competitiveness indicators from the finance and carbon performance perspective.

Category	Indicator	Measurement
Finance	Sales growth rate	%
	Profit growth rate	%
	Asset growth rate	%
	Return on net sales	%
	Stock price increase rate	%
Carbon	Greenhouse gas emissions	tCO ₂ e/year
	Carbon efficiency	tCO ₂ e/sales
	Reduction rate of greenhouse gas emissions	%
	Increase in carbon efficiency	%
Energy	Energy consumption	Total Oil Equivalent (TOE)/year
	Energy efficiency	TOE/sales
	Increase in energy efficiency	%

5. Discussion: Practical Guidelines for Implementing the Balanced Scorecard-Based Corporate Competitiveness Model of Climate Change

By applying the BSC-based climate change competitiveness model proposed in this study, firms can identify current and potential challenges engendered by climate change and develop a plan for continuous improvement. This section presents some guidelines and advice that should be considered based on management innovation tools for practitioners who wish to utilize this evaluation model.

First, this BSC-based system is more effective when applied along with the business process management (BPM) innovation technique. BPM is generally understood as a managerial principle that provides governance for improving agility and operational performance in a dynamic and complicated business environment [49] and has been widely used as a management innovation tool. BPM enables firms to better rationalize and improve the efficiency of their business processes through automation, consolidation, and optimization of internal and external corporate resources. By employing BPM, firms can build a sustainable management system that increases corporate value. BPM emphasizes cross-functional processes, which are fundamentally parallel to the corporate response to climate change and are deployed through an entire organization's engagement, rather than the activities of an individual department. Once BPM and the present climate change competitiveness

model are consolidated, companies can utilize specific and practical methods to streamline strategy implementation processes. For example, some bottlenecks in the internal process hamper a consistent and quick response to customer demands, which in turn causes low customer satisfaction and, ultimately, low market and financial performance. Therefore, competency in internal management processes should not only be understood as an operations-level supplementation or improvement but also as a critical strategy implementation tool. The application of field-based innovation tools dedicated to the diagnosis and improvement of process efficiencies, such as activity-based costing and visual mapping, helps smoothly disaggregate and disperse the upper-level, strategy-focused, BSC competitiveness evaluation system at the operations level.

Second, the BSC-based climate competitiveness model relies on visualizing innovation activities, which enables the entire organization and its employees to recognize and share core business processes in which actual improvements take place. Visualizing and exposing the process helps all members of the firm have a clear and coherent understanding of the company's goals and strategies in response to climate change. Process visualization can also transform individual capabilities into organizational competencies by converting tacit knowledge that is limited to specific persons or departments into explicit knowledge and thus facilitate knowledge sharing. In response to climate change at an organizational level, a diverse range of information, skills, and knowledge dedicated to energy, environment, and carbon fields should be extended and incorporated into core business processes, including product development, procurement and supply chain management, marketing, and capital financing. For this reason, the knowledge socialization process should run parallel with the implementation of the BSC-based climate change competitiveness system.

Third, this model should be linked with performance monitoring and continuous improvement activities. Firms can detect current and potential issues through monitoring systems, which consist of procedures for measuring, analyzing, evaluating, and interpreting data. Once issues are identified and shared at the organizational level, potential solutions for the problems, as well as their possible causes, can be discovered and discussed in a more participatory environment. Such monitoring systems must be embedded into the management system when implementing the climate change competitiveness model. If they are not equipped with monitoring and continuous improvement practices, firms' strategies for addressing climate change are likely to fall short as mere one-time initiatives or empty talk. In addition, successful implementation of the present BSC-based model requires a department dedicated to monitoring corporate climate change performance and ensuring continuous improvement. A continuous process of monitoring and improvement is, therefore, a critical antecedent for implementing this competitiveness evaluation model of climate change into an organization.

Collectively, the BSC-based competitiveness system of climate change can be more successfully adopted and implemented in an organization when the prevalent best practices regarding innovation, such as business process management, process visualization, and monitoring and continuous improvement, are consolidated as supportive and supplementary tools (Figure 2).

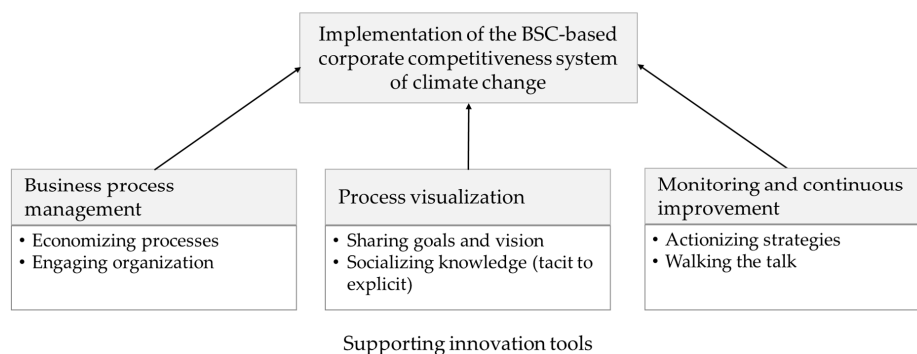


Figure 2. Consolidation of the BSC-based system with prevalent best practices in innovation.

6. Conclusions

The Paris Agreement, which came into effect in 2015, has urged the world to transition to a low-carbon economy. Companies have been increasingly under pressure to proactively address climate change issues in their management and strategy deployment because climate change may transform their business environment, which includes markets, supply chains, and labor, as well as legal systems. In this changing context, this conceptual study proposes a corporate competitiveness evaluation model regarding climate change that guides practitioners to measure, diagnose, and evaluate climate change competitiveness and performance and, thus, seek opportunities for improvements. The results of this study are summarized as follows. First, by adopting the Balanced Scorecard concept, this study developed a corporate climate competitiveness evaluation model for use with the four balanced perspectives of learning and growth, internal processes, external stakeholders, and financial and carbon performance. Second, this study defined the core performance areas for each of the four perspectives and, accordingly, proposed performance measurement indicators for practical use. The indicators comprise both qualitative and quantitative methods, which can be immediately applied and used in the field according to a firm's purpose. Third, we presented practical guidelines for practitioners to use in the successfully adoption and implementation of this BSC-based climate change competitiveness system in business organizations through its consolidation with conventional management innovation tools, such as business process management, process visualization, knowledge socialization, and monitoring and continuous improvement.

This conceptual study makes at least three contributions to the extant literature. First, it constitutes one of the earliest studies to focus on developing a framework for the corporate competitiveness of climate change. This framework can be used to monitor and evaluate the current level of corporate climate change competitiveness and therefore helps firms seek opportunities for continuous improvements. In particular, this BSC-based climate competitiveness evaluation system provides business practitioners with a better understanding of the potential factors of climate change that may affect changes in the business environment and performance outcomes. Second, this study serves as a preliminary reference on the relationship between climate change, business competitiveness, and financial performance. It utilizes an integrated performance measurement system that simultaneously evaluates both financial and non-financial performances, such as stakeholders' satisfaction, internal process efficiency, and organizational learning and innovation, to measure climate change competitiveness. This study not only provides a balanced perspective but also advances plausible theoretical explanations for the casual relationship. Third, the indices suggested in this study can also be utilized to develop measurement scales for future empirical studies. Collectively, in an exploration of the question, "Does it pay to be climate change-conscious?" this study can provide both practitioners and researchers with practical guidelines, a theoretical lens, and specific measurements.

To conclude, this article provides practical implications for policymakers and business professionals who wish to proactively address climate change. First, companies must utilize the present evaluation model to assess their competitiveness in response to climate change issues and develop carbon strategies to seek new business opportunities and mitigate carbon risks. Second, the study's results provide external stakeholders, particularly those in the capital market, such as financial investors and credit rating agencies, with a useful tool for closely estimating corporate value. Third, policymakers should encourage firms to actively participate in climate change policy-making processes. Companies are likely to be reluctant to cooperate with new carbon policies, such as the emission trading scheme and carbon information disclosure. To overcome such resistance, policies must be designed such that they are favorable to climate change competitive companies. Therefore, various types of incentives should be provided to companies seeking ways to improve their business competitiveness through adequate responses to climate change. Fourth, management studies have an increasing interest in climate change; however, very few data on corporate competitiveness regarding climate change have been accumulated to examine the effects of firms' different responses in addressing climate change issues. Using this present model, the academic community can develop constructs

and measurement scales and, thereby, collect more data. Once the data regarding climate change based on this BSC-based evaluation model are linked with existing and extensive business statistical databases, new possibilities for unexplored academic research topics in the field of climate change and management studies may be revealed.

By clarifying some of the limitations of this study, we suggest directions for future research. First, this is a conceptual study and the model's validity was therefore not tested. Future research could first elaborate on this competitiveness evaluation model and indicators through case studies and empirically test it using a large sample. Second, this study did not thoroughly consider different contexts, such as various industries, sectors, and countries. In particular, firm size and environmentally sensitive sectors may have significant effects on the corporate competitiveness of climate change [4]. Further studies specifying climate change competitiveness indicators that better reflect these contextual differences are needed. Third, the present model focuses on the mitigation of climate change rather than the adaptation to it; thus, few indicators of adaptation are presented. In future research, the present model could be extended to include firms' capabilities of adapting to volatile conditions engendered by climate change. Firms' resilience to unexpected disruptions, such as extreme weather and atmospheric blocking events should be elaborated to evaluate adaptation competitiveness, e.g., [45,50]. Fourth, the long-term effect of corporate competitiveness should be traced. Using the framework and measurement suggested by this study, further studies should collect panel data compiled over three or more years to provide a longitudinal analysis, which would yield a more robust and less biased result.

Author Contributions: J.K.M. designed the study and led the development of the research model. H.-T.A. elaborated the research model and co-developed the specific indicators. S.-Y.L. wrote the manuscript with several practical implications, and J.K.M. and H.-T.A. read and approved the final manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. The learning and growth perspective: Corporate competitiveness evaluation criteria of climate change (qualitative evaluation).

Indicator	Diagnosis (Measurement) Question	To What Extent Do You Agree or Disagree with Each of the Following Statements (1 = Not at All, 4 = Moderately, 7 = Great Extent)? 1: Laggard ... 4: Wait-and-See Observer ... 7: Leader
Climate change entrepreneurial proactivity	Our company has been well aware of the potential impacts of climate change issues on your current and future business	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
	Our company has been identifying a business opportunity from climate change challenges	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
	Our company has been considering climate change issues in your strategic management decision-making process	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
Committee for climate change-related management practices	In order to strategically respond to climate change, our company has established an independent board or committee and is actively participating in its management decision-making process.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
Work-level cooperation of corporate climate change-related management practices	The topics tackled by our company's climate change board undergo adequate discussions at the working level.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
Diversity of committee members	Our company's decision-making board on climate change measures includes staff from various departments.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7

Table A2. The internal process perspective: Corporate competitiveness evaluation criteria of climate change (qualitative evaluation).

Indicator	Diagnosis (Measurement) Question	To what Extent Do You Agree or Disagree with Each of the Following Statements (1 = Not at All, 4 = Moderately, 7 = Great Extent)? 1: Laggard ... 4: Wait-and-See Observer ... 7: Leader
Establishment of strategies and management system to address climate change issues	Our company has established and is implementing middle- to long-term strategies that respond to climate change.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
	Our company has integrated the topic of climate change in our business activities.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
	Our company has built a management system intended for climate change actions.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
Systematic evaluation of the impact of climate change issues on businesses	Our company is evaluating the effects of our general business activities on climate change.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
Streamlining of corporate practices in response to climate change measures	Our company's business process on climate change measures is highly efficient (relative to that of competitors within the same industry).	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
Level of inventory system	Our company has a sophisticated carbon inventory recording system (relative to that of competitors within the same industry).	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7

Table A3. The external stakeholder perspective: Corporate competitiveness evaluation criteria of climate change (qualitative evaluation).

Indicator	Diagnosis (Measurement) Question	To what Extent Do You Agree or Disagree with Each of the Following Statements (1 = Not at All, 4 = Moderately, 7 = Great Extent)? 1: Laggard ... 4: Wait-and-See Observer ... 7: Leader
Consumer satisfaction	Our customers' (clients') level of satisfaction towards our climate change measures is high (relative to that of competitors within the same industry).	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
Association with government carbon policies	Our company is managing an internal program that is associated with government's climate change policies.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
	Our company has established and is pushing forward cooperation plans with external stakeholders that are related to climate change measures.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
Participation in government policies	Our company is actively participating in the government's process of establishing climate change policies.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
Disclosure of carbon information	Our company is periodically disclosing information on our greenhouse gas emissions and energy consumption to external parties.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
Disclosure of reduction goals	Our company is actively disclosing our greenhouse gas reduction goals to external parties.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
Disclosure of carbon performance	Our company is accurately disclosing our greenhouse gas reduction performance to external parties.	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7
Response to the CDP request	Our company is actively responding to the demands of the Carbon Disclosure Project (CDP).	1 ... 2 ... 3 ... 4 ... 5 ... 6 ... 7

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