Revista ARACÊ
ISSN: 2358-2472

BALANCED SCORECARD IN ENVIRONMENTAL SCIENCES: A TOOL FOR SUSTAINABLE MANAGEMENT

https://doi.org/10.56238/arev7n5-280

Date of submission: 04/19/2025 **Date of publication:** 05/19/2025

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ABSTRACT

This article proposes the implementation of the Balanced Scorecard (BSC) as a management tool adapted to environmental sciences, focusing on integrating economic and ecological objectives. The research explores how the BSC can be employed to promote sustainable management that addresses natural resource conservation and climate change mitigation. Using secondary data and a descriptive approach, the study examines the feasibility of incorporating a new sustainability perspective into the traditional BSC model. The article highlights that by adding environmental and social indicators, the BSC can become a more comprehensive and effective strategic tool, capable of responding to regulatory pressures and stakeholder expectations. However, the absence of quantitative analyses and empirical testing underscores a gap in validating the proposed model, indicating the need for future studies to consolidate this integration.

Keywords: Balanced Scorecard. Sustainable management. Environmental sciences. Sustainability. Environmental indicators. Theoretical model.

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ISSN: 2358-2472

INTRODUCTION

As the effects of human activities on the environment become more visible, environmental issues have received increasing attention. In the field of environmental sciences, it is crucial that institutions adopt methods that combine financial indicators with objectives aimed at ecological conservation. The Balanced Scorecard (BSC) emerges as a relevant strategic tool for monitoring and managing these aspects, offering a holistic view of long-term impacts. This study seeks to explore how the BSC can be adapted to support the management of environmental challenges, especially in combating climate change and conservation of natural resources.

According to de Silva et al. (2020) in the last 30 years, changes in the organizational and economic environment have required innovations in management practices, driven by factors such as technological evolution and the search for efficiency in cost structures. Management accounting, acting as a tool to support the decision-making process, has stood out in creating value and fulfilling organizational strategies, especially with the use of control systems such as the Balanced Scorecard (BSC). The BSC integrates financial and non-financial indicators, promoting a comprehensive strategic vision that facilitates adaptation to external and internal changes, while facing challenges of integrating sustainability into management practices.

In this context, the Balanced Scorecard (BSC) is presented as an effective tool that allows a business to have more comprehensive strategic management. The incorporation of sustainable aspects into the BSC enables better coordination of the organization's areas, promoting the measurement of social and environmental impacts, as well as predicting the life cycles of these issues in the market. Furthermore, the BSC is flexible and can be adjusted to meet changes in sustainability strategies. The literature review shows that this integration brings significant benefits, such as improving corporate performance and competitiveness, while responding to pressure from stakeholders and public policies (Meira et al., 2020).

Although the Balanced Scorecard (BSC) is a very important tool, its use in the environmental sphere is still quite restricted. Several organizations face difficulties when trying to incorporate sustainability indicators together with their financial metrics, resulting in a mismatch between economic and ecological goals. This disparity presents itself as a relevant challenge for the adoption of sustainable and efficient practices, both in companies

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and public institutions. As a result, the need to develop new approaches that can integrate finance and sustainability in a harmonious way becomes clear.

This study aims to investigate how the BSC can be adjusted to meet this demand, encouraging strategic management that simultaneously addresses economic and environmental aspects. The proposed methodology involves a review of the literature on the application of the BSC in different areas, in addition to the suggestion of an adapted model that can face environmental challenges, with an emphasis on reducing the impacts of climate change and protecting natural resources.

THEORETICAL FRAMEWORK

BALANCED SCORECARD RATIONALE (BSC)

Alves and Vieira (2011) analyze the Balanced Scorecard (BSC) as a management tool that emerged in the 1990s, being promoted by consultancies and the media as a strategic innovation aimed beyond traditional financial indicators, also incorporating dimensions such as customers, internal processes and organizational learning. The authors explore the concept of the BSC within the context of management fads, highlighting that, although it is proposed as a more robust alternative for long-term planning, the BSC maintains traces of previous fads, such as Management by Objectives (APO) and Tableau de Bord. Based on exploratory research carried out by the authors in a consulting company in Brazil, the challenges and adaptations of the BSC to the national context are discussed, including the flexibility of its application and the participation of client companies in the implementation process. The interviews they conducted reveal that, although the BSC offers strategic potential, it can also be misapplied when seen only as a control tool, without the necessary commitment to promote profound cultural changes within organizations. The authors conclude that the BSC, by positioning itself as a strategic tool, contributes to the re-elaboration of social control in organizations, legitimizing the centralization of decisions in top management, disguised by a discourse of participation and efficiency, and suggest that future research should focus on its influence on cultural and behavioral changes.

In turn, Coelho (2019) presents a detailed analysis of academic production related to the Balanced Scorecard (BSC) over 26 years, using data from the Web of Science. By employing bibliometric tools and specialized software, the research examines 931 articles, identifying trends in publications, more prolific authors, and journals with greater impact. The analysis shows that, although the number of publications has increased significantly in

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recent years, production is still marked by a high dispersion among journals, with only a small fraction concentrating a significant number of articles. Bradford's Law is confirmed when observing the distribution of publications, and Lotka's Law is applied to find that more than 90% of authors have published only once on the topic. In addition, the study discusses the practice of co-authorship, with an average of 2.74 authors per article, with partnerships of two or three authors predominating. The works of Kaplan and Norton, creators of the BSC, are widely cited and are fundamental to the development of the field. The research concludes that the Balanced Scorecard continues to be a relevant topic for both academia and the business sector, but suggests the need for future studies that expand the bibliometric scope to other databases and explore in more depth the practical implications of this tool.

Ferreira and Rodrigues (2011) point out that although the BSC has gained prominence, there are still criticisms regarding its lack of theoretical consistency, with some researchers questioning the cause-and-effect relationships underlying the model. However, they conclude that the BSC offers a valuable framework for strategy implementation, helping companies translate their visions into concrete actions. In addition, they also emphasize the need for more empirical research to deepen theorizing and provide more robust evidence on the impact of the BSC on companies.

The Balanced Scorecard (BSC) was created to respond to the growing complexity of management in the knowledge era, in which financial indicators are no longer sufficient to assess the performance of organizations. In this context, intangible assets, such as human capital and organizational capabilities, have become central to creating competitive advantages. The BSC proposes a methodology that complements financial indicators with non-financial perspectives, covering four main dimensions: financial, customers, internal processes, and learning and growth. In this way, the BSC is not limited to being a measurement system, but is configured as a strategic management tool, integrating the organization's mission and strategy with measurable objectives, promoting alignment and continuous feedback. However, despite being widely accepted, the BSC has faced criticism for its rigidity and for limiting external views and innovations by focusing excessively on a hierarchical and mechanistic internal logic. Research such as that by Voelpel et al. (2006) point out that, although its perspectives are flexible, the methodology can create a "tyranny" of indicators, disregarding the dynamic needs of the modern business environment. Furthermore, studies such as those by Basso and Pace (2003) challenge the linear

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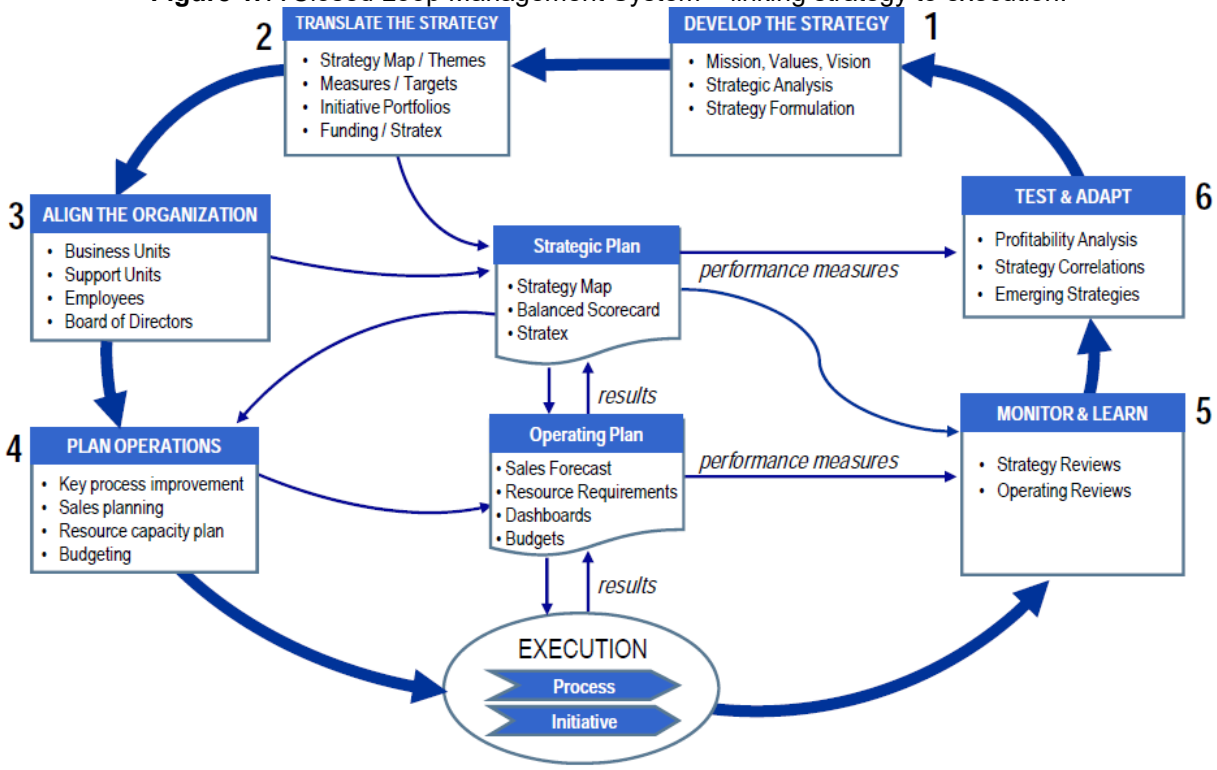
causality between BSC perspectives, suggesting a more circular and interdependent relationship between the factors analyzed (Lyrio, Lunkes & Petri, 2013).

Figure 1. A Closed Loop Management System – linking strategy to execution.



Source: Kaplan and Norton (2008a: 4).

The Balanced Scorecard (BSC) implementation process described in the figure above involves five main phases. Phase 1 involves strategy development, using tools such as SWOT analysis, mission and vision, and competency definition to create the strategic foundation. Phase 2 translates the strategy into objectives and initiatives, using strategic maps and scorecards to communicate the plans throughout the organization. Phase 3 focuses on operational planning, implementing initiatives to improve processes, quality management, and resource allocation, generating specific performance indicators. Phase 4 is dedicated to monitoring and learning, where managers review performance and identify barriers to strategy execution. Finally, in Phase 5, the strategy is tested and adapted as necessary, allowing for adjustments or reformulations based on market conditions and results obtained. These five phases form a continuous cycle that integrates strategic planning with operational management, and promotes continuous organizational learning, as the BSC evolves (Ferreira; Rodrigues, 2011).

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However, the implementation of the BSC may face challenges, such as lack of commitment from top management, inadequate communication and imbalance between the four perspectives. Despite these difficulties, the BSC is an ongoing management methodology that requires a strategic approach rather than a merely tactical focus. Case studies indicate that successful implementation depends on a formal structure, clear communication processes and a well-defined division of roles and responsibilities, in addition to a strategy that permeates all hierarchical levels of the organization (PRIETO et al., 2006).

Strategic planning is an essential tool for organizational management, being widely adopted in both the private and public sectors. The Balanced Scorecard (BSC) was initially used in the private sector, but from the 2000s onwards, it began to be applied in Brazilian public organizations as a way to improve management and the efficient use of resources. Several studies, such as those by Osório (2003) at the Municipal Institute of Public Administration and Silva (2014) at Infraero, demonstrate that adapting the BSC to the public sector presents challenges, but also offers advantages, such as improving strategic management and improving the allocation of responsibilities. The BSC helps to align internal objectives and processes with effectiveness and efficiency, in addition to adapting to the peculiarities of each institution. Although there are still challenges in its implementation in the public sector, the results indicate that the BSC is a valuable tool for improving performance and decision-making in public organizations, and that continued studies are essential for its adaptation and effective application (Bezerra et al., 2020).

In recent decades, the public sector has had to deal with the need to improve its performance, increase transparency and demonstrate results, which has led to the adoption of private sector management practices, such as the Balanced Scorecard (BSC). The BSC enables the alignment of organizational strategies and goals, while promoting the efficient use of resources and seeking to reconcile the interests of diverse stakeholders, such as government, employees and citizens. However, the implementation of this methodology in the public sector faces difficulties due to the specific characteristics of this environment, such as rigid hierarchies and frequent changes in political direction. A case study of a Brazilian public institution addressed the process of formulating and implementing the BSC, analyzing the strategic objectives and suggesting improvements in the indicators, especially from the perspective of "Learning and Growth". Although the BSC offers several advantages, its application in the public sector still faces challenges, requiring the

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adaptation of operational indicators and alignment with the organizational culture. Further studies are recommended to optimize this implementation (Muscat, De Biazzi and Miguel, 2007).

SUSTAINABLE MANAGEMENT AND ENVIRONMENTAL INDICATORS

Sustainable management and environmental indicators are essential pillars for Sustainable Development, a concept that seeks to meet current needs without compromising future generations. This principle is deeply linked to the role of organizations through Corporate Social Responsibility (CSR), which is based on the responsible use of natural resources. In this sense, a bibliometric analysis of international publications between 1945 and 2015 highlighted this intersection, evidencing seven main issues. Among them are the factors that influence the adoption of sustainable initiatives, the evaluation of corporate performance related to CSR, and the social and environmental impacts of business activities. Since 2009, there has been a significant growth in interest in these topics, with journals such as the Journal of Business Ethics and Corporate Social Responsibility and Environmental Management standing out. In addition, the research also highlighted the centrality of stakeholders as influencers in corporate decisions on sustainability. Thus, the adoption of sustainable strategies by companies has proven to be fundamental for long-term success, both in economic terms and in terms of reputation and positive social impact. The analysis suggested new methodological approaches, such as deepening the ontology of concepts and creating sustainable performance assessment frameworks, in addition to highlighting research gaps, such as the impact of sustainability reports on business practices (SILVEIRA; PETRINI, 2018).

Complementing this panorama, the concept of "triple bottom line" (TBL), introduced by John Elkington in 1994, brought a new definition of business success by integrating profit, social and environmental impact as central pillars of sustainability. However, despite being widely accepted by academia, the use of TBL in the corporate environment has faced challenges, especially in measuring and reporting non-financial impacts. Elkington, 25 years after the creation of TBL, criticized the distorted application of the concept, noting that profit is often prioritized at the expense of social and environmental dimensions, contradicting the original idea of balance between these areas. In this context, many companies use TBL as a marketing tool, rather than a genuine commitment to sustainability. Thus, the literature review emphasizes the need for a new holistic model that incorporates

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additional capabilities, such as greater transparency and cooperation between stakeholders, to face contemporary challenges of global sustainability and promote the true integration of the three pillars in corporate strategies (LOVISCEK, 2021).

Furthermore, the impact of population growth and technological development has intensified the consumption of natural resources, which in turn has increased environmental awareness and pressured companies to adopt more sustainable practices. The concept of sustainable development, which gained relevance at the Stockholm Conference in 1972, was strengthened in 1997 with the creation of the Global Reporting Initiative (GRI), which encouraged companies to publish sustainability reports. The application of the Triple Bottom Line (TBL) model was analyzed in a study by Paz et al. (2018), who investigated the sustainability of two Brazilian companies in the cosmetics sector. Using the TOPSIS multicriteria technique, the study compared the performance of these companies based on their reports, highlighting that, over three years, Company 2 outperformed Company 1, mainly in the areas of training and energy consumption. These results indicated that sustainable practices not only increase competitiveness and corporate image, but also suggest the need for further research on multi-criteria methods and the assignment of weights to performance indicators (PAZ et al., 2018).

In the context of companies seeking greater competitiveness, technological advances and growing concern for the environment have led to the adoption of environmental management practices. These practices have become essential to ensure success in the global market. The Environmental Management System (EMS), especially under the NBR ISO 14001 standard, aims to minimize the environmental impacts generated by production processes. It is worth noting that this system is monitored by environmental performance indicators, which can be classified as managerial or operational. These indicators play an essential role in aligning environmental goals with business strategies, promoting continuous adjustments and improvements. However, it is important to remember that the appropriate choice of indicators is crucial, as many can be complex or vague, making their practical application difficult. Therefore, clear alignment between indicators and organizational objectives is essential for the success of the EMS (Campos; Melo, 2008).

Regarding environmental indicators, they are divided into three main categories: Condition, Pressure and Response. These indicators are essential tools for assessing the environmental performance of companies, helping to simplify complex data and facilitate

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decision-making. They allow monitoring the use of natural resources, measuring the success of implemented strategies and identifying deviations that need correction. Thus, the effective application of clear and objective indicators, as recommended by ISO 14000 standards, can result in continuous improvements in production processes, cost reduction and greater compliance with environmental regulations. In addition, these indicators promote efficiency and sustainability, strengthening companies' commitment to environmental preservation (Ucker; Kemerich; Almeida, 2012).

Finally, this study proposes to discuss how environmental performance indicators, widely used to monitor and evaluate the impact of business activities on the environment, can be integrated into the Balanced Scorecard (BSC) model. This integration allows organizations to align their environmental goals with their strategic objectives in a more effective and structured manner. Throughout the discussion, practical examples will be presented of how environmental indicators can be distributed across the four BSC perspectives – financial, customers, internal processes, and learning/growth – demonstrating how this adaptation can help companies promote sustainability and improve organizational performance in a balanced and strategic manner.

1. **Financial Perspective**: The adoption of environmental indicators, such as operating costs related to environmental impacts and investments in clean technologies, should be integrated into the BSC to monitor the financial impact of environmental actions. Environmental management can generate savings by reducing waste and improving energy efficiency, and these gains should be reflected in the organization's financial goals, ensuring long-term competitiveness.
2. **Customer Perspective**: Indicators related to compliance with environmental standards and customer satisfaction with the company's environmental performance can be incorporated into the BSC to measure the response of consumers and regulators. Performance indicators such as the number of environmental certifications and complaints related to the environment are essential to ensure that the organization meets market expectations and maintains a positive image in the eyes of an increasingly conscious public.
3. **Internal Processes Perspective**: Here, operational indicators related to waste control, emissions and resource consumption (water, energy) are crucial to ensure efficient production processes with a lower environmental impact.

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Measurement of the use of recycled materials, the generation of hazardous waste and compliance with sustainability goals must be continuously monitored to identify areas for improvement in internal processes.

4. **Learning and Growth Perspective**: Indicators related to employee training and environmental awareness, such as the number of training sessions and the implementation of environmental management programs, fall within this BSC perspective. Promoting environmental culture within the organization is essential to ensure that the team is prepared to implement the necessary actions and maintain sustainability over time.

By integrating these indicators into the BSC, organizations can align their environmental strategies with their financial and operational goals, ensuring that sustainable performance is measured broadly and accurately, contributing to continuous improvement and sustainable competitiveness.

ADAPTING THE BSC TO THE ENVIRONMENTAL CONTEXT

Based on what has been discussed in this paper, we propose the creation of a new perspective for the BSC: Sustainability, which is a strategic innovation that aims to include metrics and indicators directly related to environmental preservation and the sustainable use of natural resources. Its objective is to ensure that sustainability principles are not only integrated into operational and financial decisions, but that they are a central and measurable part of the organizational strategy.

Main Indicators from the Sustainability Perspective:

1. Reduction of Greenhouse Gas (GHG) Emissions:

- Objective: Reduce the carbon footprint of operations.
- Indicator: Tons of CO_2 emitted per production unit or per year.
- Target: Reduce emissions by a set annual percentage, promoting the use of clean technologies and renewable energy sources.

2. Efficiency in the Use of Natural Resources:

- Objective: Optimize the consumption of resources such as water, energy and raw materials, adopting more efficient practices.
- Indicator: Water/energy consumption per unit of production or per employee.
- Target: Reduction in the use of natural resources per year, through recycling and more sustainable production processes.

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3. Waste Management and Environmental Impact:

- Objective: Minimize the generation of waste and ensure correct disposal and recycling.
- Indicator: Percentage of recycled or reused waste in relation to the total generated.
- Target: Achieve high percentages of recycling or reuse of waste by a defined deadline.

4. Biodiversity Conservation:

- Objective: Protect local ecosystems and biodiversity in the areas where the organization operates.
- Indicator: Area of protected or restored habitats, and number of preserved species.
- Goal: Recover or protect X hectares of degraded areas and maintain an active biodiversity conservation plan.

5. Relationship with Local Communities:

- Objective: Promote the sustainable development of surrounding communities, with a focus on environmental education and income generation.
- Indicator: Number of environmental education and sustainable job creation projects implemented.
- Target: Expand programs that have a positive impact on local communities, reaching at least X% of people per year.

6. Compliance with Environmental Standards and Certifications:

- Objective: Ensure that the organization operates in accordance with the most stringent environmental standards, including international certifications.
- Indicator: Number of certifications obtained (such as ISO 14001) and percentage of compliance with environmental audits.
- Target: Achieve and maintain 100% compliance with all applicable environmental regulations and seek additional certifications whenever possible.

Expected Benefits of the Sustainability Perspective

- **Strategic integration**: By adding a sustainability-focused perspective, the organization ensures that economic development and environmental preservation go hand in hand.
- **Stakeholder engagement**: Transparency in environmental indicators attracts investors, customers and partners committed to sustainable practices.

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- **Innovation and competitiveness**: The search for sustainable technologies and processes promotes innovation and gives the company a competitive advantage in the market.
- **Risk mitigation**: Monitoring sustainability indicators allows regulatory and social risks to be anticipated, promoting proactive management.

The inclusion of the Sustainability Perspective in the Balanced Scorecard not only complements the four traditional perspectives, but also reflects the urgent need to integrate environmental concerns into the heart of corporate strategies. In this way, the organization positions itself competitively and in line with the principles of sustainable development, demonstrating its commitment to future generations.

CHALLENGES AND OPPORTUNITIES FOR BSC IN GREEN ORGANIZATIONS

Silva and Callado (2021) highlight that the Balanced Scorecard (BSC) has the potential to incorporate environmental aspects, adding competitive value to organizations, although the financial measurement of sustainable policies is still a challenge. The literature, however, presents few studies on the integration of the BSC with environmental issues, highlighting a gap in the area. Among the proposed approaches are the Environmental BSC, the Sustainable BSC, and the Green BSC, each suggesting ways to add environmental indicators to the traditional BSC perspectives, which include finance, customers, internal processes, and learning. Studies such as that by Johnson (1998) suggest a BSC oriented towards environmental goals, while Silva and Callado (2013) recommend adaptations from the customer perspective to include stakeholders, such as governments and regulatory bodies. According to the study by Silva and Callado (2021), the participating controllers prefer the traditional BSC structure with the inclusion of environmental indicators, reinforcing the demand for adaptations that balance sustainability and financial objectives. The research also reveals a gap in the literature regarding the implementation of a standardized environmental BSC, suggesting that future studies explore the use of the BSC in different sectors and analyze other management tools aimed at business sustainability (Silva & Callado, 2021).

The Balanced Scorecard (BSC), although widely adopted in several areas of strategic management, presents significant limitations when applied in an environmental context, particularly with regard to measuring long-term and sustainable impacts. The use of the BSC for sustainable management faces practical challenges when trying to adapt its

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traditional financial indicators to ecological needs. Organizations often encounter difficulties in incorporating metrics that reflect the environmental impact of organizational activities and aligning these data with economic objectives. In addition, there is a considerable gap in the literature addressing how the BSC can effectively serve to measure sustainable performance, pointing to a lack of consensus on the full integration of environmental and financial metrics.

The adoption of sustainability indicators alongside financial indicators also requires a rebalancing of the application of the four BSC perspectives, which are finance, customers, internal processes and learning. According to the traditional BSC structure, the emphasis is often on short-term financial and operational goals, which can limit its ability to capture and monitor environmental effects on a longer time scale. In terms of adaptation, many of the proposed indicators, such as measuring the carbon footprint and the consumption of natural resources, require an approach that prioritizes sustainability objectives, but in practice, they often encounter difficulties in meeting the short-term vision of economic return present in many organizations.

In addition to technical and conceptual barriers, implementing the BSC with an environmental focus faces structural obstacles, such as organizational resistance to change and the need for a strong commitment from senior management to sustain sustainable practices. The attempt to align sustainable objectives with traditional BSC metrics also implies constant review and managerial flexibility that is not always prioritized in organizations. In this sense, the sustainability perspective demands not only adjustments to BSC indicators, but also the adoption of an organizational culture committed to sustainability, which is not always easily achieved, reinforcing the limitations and challenges of this approach in companies and public institutions that seek to integrate sustainable development into their practices.

The integration of ESG (environmental, social and governance) practices has become essential for companies seeking sustainability, transparency and competitiveness in the market. With 83% of consumers demanding that companies lead on ESG and 76% willing to abandon brands that do not respect the environment, the pressure for responsible action goes beyond regulatory compliance, directly affecting image and profitability. During the pandemic, consumers' willingness to pay more for sustainable brands has increased, reinforcing the need for robust and transparent actions. However, there is a gap between public expectations and companies' perception of their role in ESG, with 91% of business

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leaders recognizing the responsibility to act, but often without standardized metrics to measure these efforts. Digital technologies, such as Microsoft Cloud for Sustainability, have been instrumental in integrating emissions, water and waste data, simplifying the collection and analysis of data from multiple sources, from IoT[7] sensors to third-party suppliers. The partnership with companies like McKinsey, focused on decarbonization solutions, exemplifies how technological collaboration can accelerate the transformation towards sustainability. However, the challenge of standardizing the measurement of ESG factors still persists, with efforts by organizations such as the World Economic Forum to create common metrics and foster transparency in data. This is crucial for financial institutions to be able to identify green investment opportunities, ensuring that sustainability is a strategic priority and not just a regulatory obligation, contributing to economic growth that respects environmental limits (MICROSOFT, 2024).

To broaden the discussion on the role of the Balanced Scorecard (BSC) in climate risk management, we can highlight that this tool can be adapted to face the challenges of climate change, integrating specific sustainability indicators into its traditional perspectives. By adding a new dimension focused on sustainability, such as the “Sustainability Perspective”, the BSC can monitor indicators such as greenhouse gas emissions reduction, efficiency in the use of natural resources and waste management. This allows organizations to adapt their strategies to climate demands, reducing their carbon footprint and promoting decarbonization practices.

The use of accurate data, including from IoT sensors and platforms such as Microsoft Cloud for Sustainability, facilitates the monitoring of environmental metrics, enabling rapid and effective corrective actions. Furthermore, by aligning these metrics with financial and operational objectives, the BSC helps companies position their profitability goals with their commitment to mitigating climate impacts, promoting a balance between sustainability and economic performance. This integration not only improves transparency for ESG-conscious investors and consumers, but also helps companies better prepare for future environmental regulations by providing a strategic view that considers climate variations in their decision-making processes. Thus, the BSC becomes a robust tool for

[7] IoT (Internet of Things) sensors are devices that collect data from the environment, such as temperature, humidity or movement, and transmit it via the internet for analysis and remote monitoring, enabling automation and process control.

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addressing climate risks, enabling more proactive and strategic management of environmental issues.

INTERSECTION WITH PUBLIC POLICIES AND EXTERNAL PRESSURES

Global environmental degradation, intensified by human activities since the Industrial Revolution, has generated a series of adverse impacts, such as the overexploitation of natural resources, the growth of greenhouse gas emissions and disorderly urbanization. Such actions have placed crucial ecosystems, such as tropical forests, oceans and Arctic zones, at increasing risk, highlighting the urgency of environmental preservation actions. In Brazil, the National Climate Change Plan (NCCP), established in 2008, has become a central instrument for mitigating emissions and adapting to climate change, defining guidelines and goals for more integrated and participatory environmental management. Environmental legislation, based on the 1988 Constitution and subsequent regulations, plays an essential role in protecting natural resources, while regulation seeks to standardize and monitor activities that may cause negative impacts. In addition, environmental education is essential to raise awareness among the population and promote sustainable practices, generating collective engagement in climate policies. However, the implementation of the NCCP faces challenges, such as lack of resources, institutional discontinuity and the absence of effective integration between different levels of government and civil society. Research indicates that cities such as Recife and Salvador have stood out with robust climate action plans and adaptation policies integrated into their master plans, but other capitals still have deficiencies in the formalization of specific mitigation and adaptation strategies. The influence of international agendas, such as the Sustainable Development Goals (SDGs) and the Paris Agreement, reinforces the need for a more coordinated approach to address climate challenges. The proposal for new sociocultural indicators aims to fill the gaps in the assessment of policy effectiveness, offering a broader analysis that considers not only the quantitative impacts, but also the social and cultural aspects of climate adaptation. The research reinforces that, for Brazil to achieve its mitigation and adaptation goals, it is essential to overcome the obstacles to the practical implementation of climate policies, ensuring that the PNMC guidelines are applied efficiently and contribute to building a more sustainable and resilient future (OLIVEIRA JUNIOR et al., 2024).

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In addition to federal governments, the responsibility for adapting to and mitigating climate change also falls to states and municipalities, with cities being key players in this process. Cities, due to their population density and activities that are intensive in emitting greenhouse gases, are both vulnerable to the impacts of climate change and significant contributors to this problem. Examples such as floods in Asia and droughts in Cape Town illustrate the consequences of these phenomena, affecting millions of people. At a global level, urban areas are responsible for 75% of greenhouse gas emissions, resulting mainly from activities such as transportation and construction. With rapid urban growth, which already exceeds 55% of the world's population in urban areas, the need for effective local responses becomes urgent. However, these responses face challenges such as inadequate infrastructure and institutional inertia that hinder the implementation of climate policies, especially in megacities and developing countries. Furthermore, Brazilian cities, despite having master plans, often fail to explicitly integrate climate mitigation and adaptation measures, highlighting the need for greater alignment between urban policies and global goals, such as the Paris Agreement (Espíndola and Ribeiro, 2020).

According to the World Resources Institute (WRI), China, followed by the United States, the European Union and Brazil, is among the largest emitters of greenhouse gases, responsible for more than two-thirds of global emissions. In 2017, the United States announced its withdrawal from the Paris Agreement, claiming that it would harm its economy, thus becoming one of the few countries not to participate in this climate commitment. Despite the decision, several US states and cities, as well as global leaders and organizations, reaffirmed their commitment to the goals of the Paris Agreement, aiming to limit global warming to 1.5°C above pre-industrial levels by 2030. The United States' withdrawal sparked international reactions, with the European Union and China taking the lead on climate policy, while the French president stressed the importance of preserving the planet, emphasizing that "there is no Planet B." Even so, the absence of one of the largest emitters from the agreement weakens global efforts to reduce emissions, although subnational actions and corporate commitments are underway to mitigate impacts (Bruno and Fraga, 2018).

The implementation of environmental policies, such as the Paris Agreement or local environmental preservation regulations, can influence the adaptation of the Balanced Scorecard (BSC) in organizations by adding a sustainability-oriented perspective, which includes specific metrics for emissions reduction, resource efficiency and waste

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management. These policies establish guidelines that encourage organizations to integrate environmental goals into their strategic objectives, aligning environmental preservation with the traditional financial and operational indicators of the BSC. This can result in an adaptation of the BSC that meets regulatory and social requirements, promoting more sustainable and balanced management.

The importance of considering the demands of external stakeholders, such as investors, customers and communities, who demand more sustainable practices from organizations, is highlighted by the growing pressure and expectations regarding environmental commitment. This work addresses how sustainable practices and alignment with Corporate Social Responsibility (CSR) not only respond to these expectations, but also provide economic and competitive advantages. The adoption of metrics that integrate environmental indicators into the Balanced Scorecard model allows organizations to meet these demands in a structured manner, ensuring proactive and transparent management that can strengthen reputation, attract new investments and serve consumers, who increasingly value environmentally responsible companies.

THEORETICAL MODEL

The Sustainable Balanced Scorecard, adapted for environmental sciences, is a management tool that expands on the traditional model proposed by Kaplan and Norton. The innovation here lies in the explicit inclusion of the Sustainability Perspective, which aims to harmonize organizational operations with ecological principles, ensuring that strategic decisions consider long-term impacts on the environment. This integrative approach adapts to current demands, which require business practices that promote the preservation of natural resources and the mitigation of climate change.

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Financial Perspective: This component of the Sustainable BSC monitors operational costs and investments related to sustainability. Environmental management is seen as an economic asset, where efficiency in the use of resources can result in significant savings and financial gains, without neglecting economic viability. Typical indicators include the analysis of savings generated by environmentally friendly processes and the return on investments in clean technologies.

Customer Perspective: This perspective measures the response of customers and regulators to the organization's environmental initiatives. Alignment with environmental standards, as well as customer perceptions of the company's environmental responsibility, are essential. Indicators include the number of environmental certifications and customer satisfaction related to environmental commitment, highlighting the importance of a positive corporate image that meets the expectations of an increasingly aware public.

Internal Processes Perspective: Performance indicators are established here to optimize processes to minimize environmental impacts, such as energy efficiency, waste management, and sustainable water use. This includes strict waste control and efficient use of natural resources, promoting greener production processes.

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Learning and Growth Perspective: The focus is on empowering employees to sustain an organizational culture focused on sustainability. Indicators related to environmental education, such as training and workshops, are used to ensure that the workforce understands and adopts environmentally friendly practices. Continuous learning and awareness foster a corporate environment that supports sustainable innovations.

Sustainability Perspective: This new dimension is the essence of the Sustainable BSC, including indicators such as the reduction of carbon emissions, efficiency in the use of natural resources, and the conservation of biodiversity. By including this perspective, sustainability becomes a central part of the organizational strategy, with clear metrics to monitor and manage environmental impacts.

METHODOLOGY

The methodology of this study was developed to explore the application of the Balanced Scorecard (BSC) in environmental sciences, with the aim of integrating financial and ecological indicators and promoting sustainable management of natural resources and climate practices. The approach adopted consisted of a descriptive research based on three main pillars: literature review, data analysis and modeling of the Sustainable BSC.

1. **Bibliographic Survey:** The first stage involved an extensive literature review on the adaptation of the BSC to the environmental context. Academic articles and case studies that discuss the application of the BSC in organizations committed to sustainable practices were analyzed. The objective was to identify the main challenges and innovations in the implementation of environmental metrics within the traditional BSC model.
2. **Secondary Data Collection:** The research was based on the analysis of secondary data from relevant academic publications. These data were selected to measure the effectiveness of the BSC in the sustainable management of organizations, considering the adequacy of financial and ecological indicators, the integration of environmental goals and the influence of external factors, such as regulations and social pressures. The use of reliable and comprehensive sources ensured the relevance and accuracy of the data used in the modeling and subsequent analysis.
3. **Descriptive Analysis and Discussion:** Although the study was based on secondary data, it did not use advanced statistical techniques, such as structural

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equation modeling. The analysis consisted of a critical and comparative discussion of the data collected, identifying the potentialities and limitations of applying the Balanced Scorecard in the environmental context. The absence of detailed quantitative calculations and empirical tests represents a recognized gap in this research.

4. **Considerations on the Theoretical Model:** Instead of validating or adjusting the model through statistical techniques, the applicability of the Sustainable BSC was assessed theoretically. The results were discussed in light of the existing literature, with emphasis on the need for future studies that can empirically test the hypotheses and apply quantitative methods to robustly validate the model.

This methodology seeks not only to demonstrate the effectiveness of the Sustainable BSC as a management tool, but also to highlight the importance of adopting long-term metrics that incorporate both economic benefits and environmental impacts, ensuring more balanced and sustainable management.

DISCUSSION

This study explored the potential of the Balanced Scorecard (BSC) as a strategic tool for sustainable management in the context of environmental sciences. The proposal to adapt the BSC, traditionally focused on financial and operational indicators, to include a sustainability perspective represents a relevant innovation in view of global pressures for more conscious and responsible practices. The inclusion of specific indicators, such as the reduction of greenhouse gas emissions, the efficiency in the use of natural resources and the conservation of biodiversity, offers organizations the ability to measure and manage their environmental impacts in an integrated manner. In this way, the adapted BSC becomes a framework that can help organizations balance their economic goals with the urgent need to preserve natural resources.

The study emphasized that by adding this new perspective to the BSC, organizations can align their environmental strategies with their financial goals, promoting management that considers both ecological sustainability and economic viability. The research revealed that by integrating environmental and social aspects, the BSC can meet the demands of stakeholders who are increasingly concerned about corporate practices. Transparency and responsibility regarding the environment have become strategic differentiators, especially in a scenario where consumers, investors and regulators increasingly demand commitment to

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ESG (environmental, social and governance) practices. This reinforces the relevance of adapting traditional management tools to face contemporary challenges.

On the other hand, adapting the BSC to environmental sciences presents significant challenges. One of the main obstacles is the difficulty in accurately quantifying and measuring environmental impacts, which can limit the effectiveness of the proposed model. In addition, organizational resistance to change, combined with the need for commitment from all stakeholders, can hinder the successful implementation of the adapted BSC. The lack of a corporate culture that values sustainability represents an additional barrier, demanding effective strategies for raising awareness and training employees. The research revealed that the success of the Sustainable BSC depends heavily on the engagement of senior management and the ability to adapt the tool to the specificities of each organization.

Another important issue for reflection is the methodological gap identified in the study. The research was based on secondary data and descriptive analyses, without empirical testing or quantitative modeling. This means that the proposed model still lacks validation through robust quantitative studies that can prove its practical effectiveness. The absence of statistical techniques, such as structural equation modeling, limits the ability to generalize the results and highlights the importance of future research. Future studies need to apply quantitative methodologies to empirically test the Sustainable BSC, providing a more solid basis and expanding the evidence on the benefits and limitations of this approach.

Despite these limitations, the study highlighted promising opportunities for the Sustainable BSC, especially in terms of innovation and competitive advantage. Organizations that adopt the adapted BSC can benefit from a holistic and integrated view of their performance, anticipating regulatory and social risks and promoting more efficient management of natural resources. Integrating environmental indicators into the strategic decision-making process not only helps to mitigate environmental impacts, but also contributes to long-term value creation. Companies that lead this movement will be better positioned to respond to market demands and adapt to regulatory changes, in addition to strengthening their reputation as organizations committed to sustainability.

The research also highlighted the need to rethink the role of public policies and external pressures in the implementation of the Sustainable BSC. Governments and international organizations have played a crucial role in establishing guidelines and regulations that encourage sustainable practices. Adapting the BSC to include these

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requirements can facilitate the alignment of corporate strategies with global sustainable development goals, such as the Sustainable Development Goals (SDGs) and the Paris Agreement. However, the complexity of adapting the BSC to different institutional and sectoral contexts requires a flexible and tailored approach that takes into account the specificities of each sector.

FINAL REMARKS

In short, the Sustainable Balanced Scorecard is a proposal that aims to transform organizational management by strategically incorporating environmental sustainability. The study concludes that, although the application of the adapted BSC in environmental sciences brings challenges, it also offers a significant opportunity to promote more balanced and responsible management practices. The inclusion of a new sustainability perspective not only complements the financial and operational dimensions, but also reinforces the commitment of organizations to preserving the planet. To advance in this field, future studies should focus on developing and empirically testing more robust models capable of providing quantitative evidence of the effectiveness of the Sustainable BSC and its ability to promote significant changes in organizational and environmental performance.

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