Section of the conference: Economic Sciences | Sekcja konferencji: Nauki ekonomiczne

How to cite: Viveros-Almeida, Y., Fernández-Fernández, Y., & Realpe-Cabrera, E. P. (2024). Analytical Strategy for Assessing the Sustainable Competitiveness of a Developing Region: Case Ecuador. *World conference on future innovations and sustainable solutions*. Futurity Research Publishing. https://doi.org/10.5281/zenodo.14031235

Analytical Strategy for Assessing the Sustainable Competitivenessof a Developing Region: Case Ecuador

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Accepted: October 16, 2024 | **Published**: November 1, 2024 | **Language:** English

Abstract: The study "Analytical Strategy for Assessing the Sustainable Competitiveness of a Developing Region: Case Ecuador" proposes an innovative approach to assessing sustainable competitiveness in developing regions, using Ecuador as a case study. It integrates dimensions of sustainable development (environmental, economic and social) with regional competitiveness indicators adapted to the Latin American context. The methodology employs advanced mathematical techniques and considers key factors such as institutional efficiency and human capital. The results underline the importance of technological innovation and political decentralization to promote sustainable competitiveness, suggesting policies that promote clean production and social equity, thus contributing to regional development in emerging economies.

Keywords: Sustainable competitiveness, regional development, international indicators

Introduction

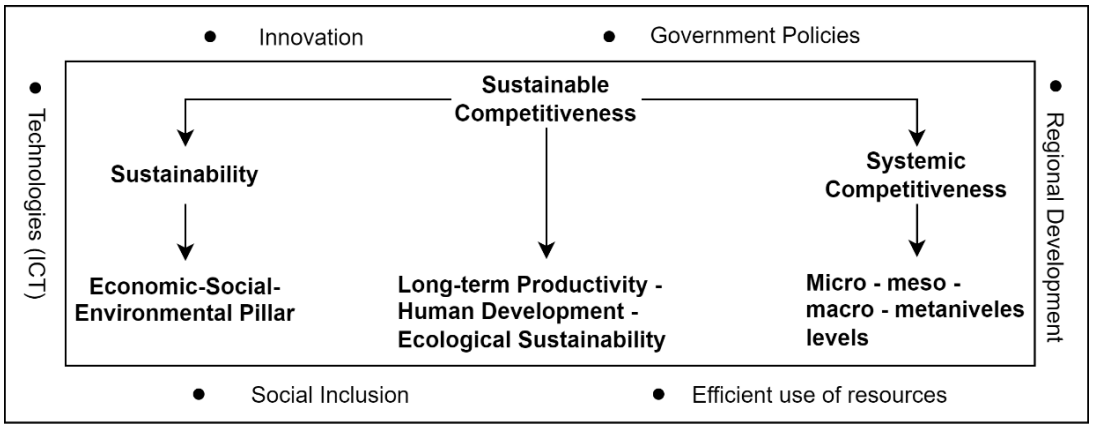
Defining and measuring regional competitiveness is challenging. (Sunder, 2005) points out that no single economic theory offers a universal definition. Key determinants such as productive capital, human capital and infrastructure are identified. (Kitson et al., 2004) proposes a concept based on six

components. (Boschma, 2004) emphasizes the evolutionary perspective. Competitiveness is linked to sustainable development, influenced by institutional, educational and financial factors. (Kouskoura et al., 2024) relate environmental aspects to infrastructure, macroeconomics, education, finance, market and innovation. Sustainable and systemic competitiveness is based on the interaction of key factors such as innovation, governance policies, technologies, social inclusion, efficient use of resources and regional development (See Figure 1). These elements are essential to address the pillars of sustainability: economic, social and environmental. Innovation drives long-term productivity by facilitating efficient processes and the development of products that meet market demands. Governance policies establish a regulatory framework that promotes equity and access to opportunities, which is vital for social inclusion. Technologies optimize the use of resources, improving operational efficiency and contributing to a more sustainable economy.

Efficient use of resources is crucial to maximize production without compromising the environment, resulting in balanced regional development that seeks not only economic growth, but also social welfare and ecological conservation. In this context, ecological sustainability is reinforced by practices that minimize environmental impact and promote the conservation of natural resources. Systemic competitiveness is analyzed at the micro (firms), meso (sectors), macro (national policies) and meta (global interactions) levels.

Figure 1

Influencing Factors in Sustainable Competitiveness



At the micro level, companies must adapt to changing environments through continuous innovation. At the meso level, sectoral policies must facilitate collaboration among economic actors. The macro level establishes general conditions for investment and sustainable growth, while at the meta levels, effective integration between local and international policies is required to address global challenges such as climate change. Thus, the synergy between these factors not only strengthens competitiveness through improvements in productivity and human development, but also ensures a holistic approach to sustainability that encompasses economic, social and environmental dimensions.

A methodology for assessing sustainable competitiveness in border regions will be presented below. This methodology is based on the hypothesis that sustainable competitiveness can be analyzed through a multidimensional model that integrates economic, social, environmental and

institutional indicators, adapted to the specific characteristics of a binational border. This approach will allow the identification of strategic levers for regional development and facilitate a comprehensive analysis of the factors that influence sustainability and competitiveness.

Methodological Proposal for Assessing Sustainable Competitiveness

The evaluation of sustainable competitiveness in border regions is fundamental to the identification of development opportunities and the improvement of quality of life.

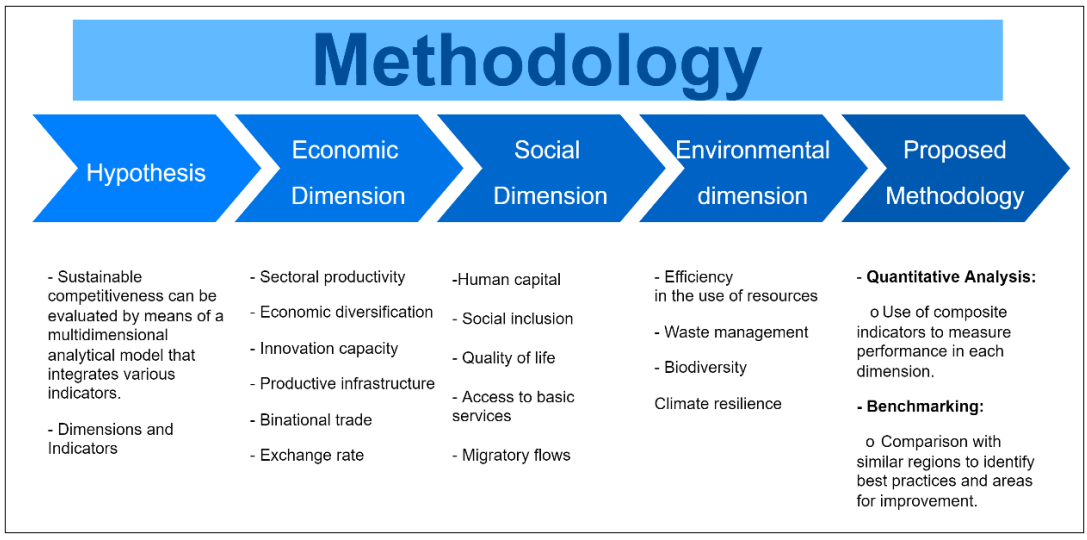
This methodological proposal is based on a multidimensional analytical model that integrates economic, social, environmental and institutional indicators, adapting to the particularities of binational contexts.

Sustainable competitiveness has become a central theme in the analysis of the economic, social and environmental development of nations and regions. This concept not only encompasses the capacity of a country or region to compete in the global market, but also implies a comprehensive evaluation of its performance in various dimensions. In this context, a multidimensional analytical model is proposed that integrates economic, social and environmental indicators to evaluate sustainable competitiveness. The central hypothesis is that this competitiveness can be effectively measured through a set of interrelated dimensions that reflect the current state and future potential of a region.

The model is structured in three main dimensions: economic, social and environmental. Each of these dimensions includes specific indicators that allow for an in-depth and detailed analysis of regional performance (See Figure 2).

Figure 2

Methodological Outline



For example, the economic dimension considers factors such as sectoral productivity and innovation capacity, while the social dimension focuses on human capital and social inclusion.

Arguing the proposed methodology, Scaccabarozzi, (Scaccabarozzi et al., 2024) propose a composite indicator to measure the competitiveness of Italian municipalities, highlighting the importance of integrating multiple dimensions in the evaluation of regional performance. (Cappellano & Kurowska-Pysz, 2020) address a mission-oriented approach to regional development, emphasizing the need for strategies that transcend boundaries and promote sustainability. (Lamichhane et al., 2021) conducts a principal component analysis to assess the sustainable development performance of OECD countries, proposing an analytical framework that allows the identification of specific areas for improvement.

(Charles & Zegarra, 2014) use data envelopment analysis to measure regional competitiveness in Peru, revealing how this method can help identify inefficiencies and opportunities for improvement in public policies. (Cherchye & Kuosmanen, 2004) present a synthetic approach to benchmarking sustainable development, creating a meta-index that allows comparing the performance of different regions in terms of sustainability. Finally, (Deng, 2015) explores the use of multi-criteria analysis to establish benchmarks in sustainable development, suggesting that this approach can facilitate informed decision-making in sustainability policies. These studies contribute to a deeper understanding of the methods and approaches needed to assess and improve competitiveness and sustainability in various regions.

On the other hand, the environmental dimension evaluates aspects such as efficiency in the use of resources and waste management. This methodology seeks not only to identify the strengths and weaknesses of each region, but also to establish a comparative framework for benchmarking with other similar regions. This comprehensive approach not only promotes a better understanding of current challenges, but also facilitates the identification of best practices and opportunities to improve long-term sustainable competitiveness.

Results and Discussion

The results and discussion section focuses on the construction of the Composite Indicator of Sustainable Competitiveness (ICCS), which is formulated as ICCS = ∑(Wi

× Si) XX, where (W_i) represents the weight assigned to each subindex and (S_i) its normalized value. This indicator is decomposed into economic, social, environmental and innovative sub-indexes, each with its own weighted structure. Through comparative analysis and benchmarking with similar regions, performance gaps are identified, and relative competitiveness is assessed using the Relative Competitiveness Index (RCI). This approach highlights best practices and areas for improvement, facilitating the transfer of knowledge and the prioritization of initiatives that promote sustainability and regional development (See Table 1).

Table 1

Quantitative Analysis and Benchmarking Approaches

• **Quantitative Analysis:** o Use of composite indicators to measure performance in each dimension. Quantitative Analysisusing Composite Indicators ***1. Construction of the Composite Indicator of Sustainable Competitiveness (ICCS)*** 1.A. Structure of the Indicator The ICCS is constructed using the following general formula: $ICCS = \sum(Wi \times Si)$. Where: Wi = Weight assigned tosubindex i Si = Normalized value ofsubindex i 1.B. ComponentSubindexes Economic Subindex (SE) $SE = 0.25(PIBpc\_n) + 0.25(Prod\_n) + 0.25(Inv\_n) + 0.25(Emp\_n)$ Where: GDPpc_n = normalizedGDP per capita Prod_n = Standardized labor productivity Inv_n = Normalized private investment Emp_n = Standardized formal employment rate Social Subindex (SS) $SS = 0.3(Edu\_n) + 0.3(Sal\_n) + 0.2(Seg\_n) + 0.2(Coh\_n)$. Where: Edu_n = Standardized educational level Sal_n = Normalized healthindicators Seg_n = Standardized	• **Benchmarking:** o Comparison with similar regions to identify bestpractices and areas forimprovement. 1. Selection of Reference Regions 1.A. Selection Criteria ***Structural Similarity*** $IS = \sum(\alpha\_i \times X\_ir - X\_ib\|)/n$ Where: IS = Similarity index X_ir = Value of indicator i inanalyzed region X_ib = Value of indicator i inbenchmark region α_i = Weight of indicator in = Number of indicators ***2. Geographic Proximity*** $PG = exp(-d/d\_0)$ Where: d = Distance betweenregions d_0 = Reference distance ***3. Comparative Analysis*** 3.A. Performance Gaps $BD = (X\_r - X\_b)/X\_b \times 100$ Where: BD = Performance gap X_r = Value of the indicator inanalyzed region X_b = Value of the indicator inbenchmark region 3.B. Relative CompetitivenessIndex $ICR = (ICCS\_r/ICCS\_b) \times 100$ Where: RCI = Relative Competitiveness Index ICCS_r = ICCS of the region under analysis ICCS_b = ICCS of thebenchmark region ***4 Best Practice Analysis*** 4.1. Identification of SuccessFactors - Multiple regressionanalysis 4.2. TransferabilityAssessment $IT = (FC \times AD \times CI)/3$ Where: IT = Transferability index FC = Contextual Feasibility(0-1) AD = Adaptability (0-1) CI = Institutional Capacity(0-1) 5. Prioritization Matrix

safety index
Coh_n = Normalized Social Cohesion Index

Environmental Subindex(SA)

$$SA = 0.3(Amb\_n) + 0.3(Rec\_n) + 0.2(Ene\_n) + 0.2(Bio\_n).$$

Where:
Amb_n = Normalized environmental quality Rec_n = Normalized resource management
Ene_n = Normalized energy efficiency
Bio_n = Normalized Biodiversity Index

Innovation sub-index (SI)

$$SI = 0.3(R\&D\_n) + 0.3(Pat\_n) + 0.2(ICT\_n) + 0.2(Cap\_n)$$

Where:
R&D_n = Normalized R&Dinvestment
Pat_n = Standardized registered patents
TIC_n = Normalized adoption of ICTs
Cap_n = Normalized innovation capacity

$$MP = I \times F$$

Where:
MP = Priority of the practicel = Potential impact (1-5)

4. Geographic Proximity

$$PG = exp(-d/d\_0)$$

Where:
d = Distance betweenregions
d_0 = Reference distance

5. Comparative Analysis

5.A. Performance Gaps

$$BD = (X\_r - X\_b)/X\_b \times 100$$

Where:
BD = Performance gap
X_r = Value of the indicator inanalyzed region
X_b = Value of the indicator inbenchmark region

5.B. Relative CompetitivenessIndex

$$ICR = (ICCS\_r/ICCS\_b) \times 100$$

Where:
RCI = Relative Competitiveness Index ICCS_r = ICCS of the region under analysis
ICCS_b = ICCS of thebenchmark region

5 Best Practice Analysis

5.1. Identification of SuccessFactors
- Multiple regressionanalysis

5.2. TransferabilityAssessment

$$IT = (FC \times AD \times CI)/3$$

Where:
IT = Transferability index
FC = Contextual Feasibility(0-1)
AD = Adaptability (0-1)
CI = Institutional Capacity(0-1)
5. Prioritization Matrix

$$MP = I \times F$$

Where:
MP = Priority of the practicel = Potential impact (1-5)
F = Feasibility ofimplementation (1-5)

The results presented are preliminary in relation to the methodology applied, which is under continuous development. Currently, several significant simulations and analyses are being carried out in Ecuador, specifically in the context of a border competitiveness project on the southern border of Ecuador and Colombia. This proposed methodological process, which includes the construction of the Composite Indicator of Sustainable Competitiveness (ICCS) and its application in economic, social and environmental sub-indices, constitutes the main contribution of this article. The initial findings will serve as a basis for future research and improvements in regional competitiveness.

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