

Profitability and Sustainability Indicators of Ecuadorian Industries: Assessment using the Logistics Biplot approach

Luis Pilacuan-Bonete^{1,*}, Pilar Macías-Suarez¹, Jesús Arcos Coba¹, and Brenda Marín Cucalón¹

¹Facultad de Ingeniería Industrial, Universidad de Guayaquil, Ave. Raúl Gómez Lince and Ave. Juan Tanca Marengo, Guayaquil-Ecuador.

Abstract. Sustainable development has gained relevance in the 21st century, raising concerns in the industry about industrial practices, preservation, and rights in the long term. This study analyzes 103 Ecuadorian companies between 2020 and 2021, using the external logistics biplot to interpret complex relationships between the sustainability indicators and their influence on various business sectors. The results reveal a significant relationship between the adoption of sustainable practices and the size of companies, as well as a greater incidence of sustainability reports aligned with the Global Reporting Initiative (GRI) in large corporations. The evaluated indicators show a remarkably high predictive capacity in both years, with classification accuracy percentages greater than 79 %. In 2020, greenhouse gas emissions and human rights indicators showed the strongest correlations. In 2021, the social dimension emerged as the most prominent, highlighting the importance of considering social aspects such as labor rights and employee well-being. These findings provide valuable insights for future sustainability research and policies in Ecuador, underscoring the need to promote sustainable practices for the economic and social development of the country.

1 Introduction

In the early years of the 21st century, the term "sustainable development" gained prominence in various manufacturing sectors, raising concerns about how to preserve the rights and practices related to their industrial activities while seeking to avoid increasing anthropogenic impacts on society [1]. The lack of transparency in industries regarding global sustainability contrasts with interpretations linked to sustainable development despite the absence of a standardized definition [2]. Since, for the most part, it is used to denote the satisfaction of current needs without compromising future needs [3] encouraging environmental practices and strategies for more responsible management [4].

The incorporation and adjustment of sustainable principles in the organizational culture has advanced in the internal and external policies of Latin American companies, reaching the point of adapting international standards to their management to improve their strategies and contributions to the work environments of their respective countries [5]. Furthermore, in the study on cultural interest in sustainable business development, the perception of social barriers that many companies face when recognizing the benefits that come with increasing the

*Corresponding author: luis.pilacuanb@ug.edu.ec

trust of interest groups is highlighted [6], which emphasizes that the transformation process takes time, especially when modifying paradigms [7].

The European publisher, "European Science Editing, advocates implementing sustainability measures within the framework of environmental policies, emphasizing the prioritization of contemporary practices [8]. A notable increase in sustainability reporting studies has been observed in Latin America. This increase has been driven by the adoption of international standards, supported by governmental entities [9] leading to the promulgation of practical guidelines such as Corporate Social Responsibility, as well as the attention to the Sustainable Development Goals and the Global Reporting Initiative [10]. Likewise, multiple studies of corporate social responsibility have been developed in different countries such as Turkey [11] or Italy [12], and some using multivariate techniques such as Biplots [13].

Focusing on the study population, Ecuador prepares an annual report in collaboration with the Ecuadorian Consortium for Social Responsibility (CERES), aligning itself with the Sustainable Development Goals (SDGs). In this way, the country's contribution is closely linked to producing goods and services that promote a sustainable and stable infrastructure [14]. The absence of similar studies in Ecuadorian Industries highlights the importance of this work as a fundamental reference for future research. Its realization offers an invaluable opportunity to assess progress toward meeting the SDGs [15]. The lack of data and the scarcity of business resources in certain sectors underscore the need to address possible cultural obstacles that could restrict the incorporation of sustainable practices.

The main purpose of this research is to carry out a multivariate analysis using methods such as the external logistic biplot comprising principal component analysis and logistic regression integrating the guidelines of the Global Reporting Initiative (GRI), which are a series of indicators that encompass three categories, such as; economic, social and environmental. The intention is to deepen the understanding of how these indicators are related and to what extent they influence sustainability among industrial sectors in Ecuador.

2 Materials and Methods

The research follows a qualitative methodology because one of its characteristics is not the quantification of a phenomenon, but it is a detailed description of qualities and interpretation according to the context studied [16][17]. It seeks to determine which companies have chosen to comply voluntarily with the sustainable reports, covering a period of analysis from 2020 to 2021.

2.1 Data Collection

One hundred-three companies from the manufacturing industry and other sectors in Ecuador were considered (<https://github.com/Pilacuan-Bonete-Luis/Sustainability-Indicator-Coding>), classifying according to size and economic activity. Data collection was carried out by obtaining information from the website (<https://appscvsmovil.supercias.gob.ec/ranking/reporte.html>), complemented with the review of sustainability reports published on the portal of the same companies or through the platform (<https://www.redceres.com/memoria>). A limitation was found in data collection, as not all reports adhere to the same parameters, structure, and due content since they present different characteristics in the specific field of interest.

The Global Reporting Initiative standards drive the development of reports for industries to report accounts to their stakeholders [18], its sustainable reporting framework details one of the versions the GRI Standard (G4) approved in 2016 [19], which promises a better quality

of data within sustainable development reports, it also recommends companies to pay more attention to social indicators [20] to their performance in reports.

As of 2020, a total of 77 companies submitted their sustainability reports. It should be noted that the economic category includes 9 indicators, while the environmental category includes 34 indicators. As for the social performance category, 48 indicators are distributed in 4 subcategories: labor practices and decent work with 16 indicators, human rights with 12 indicators, society with 11 indicators, and product responsibility with 9 indicators.

For the year 2021, a total of 73 companies made sustainable reports within which, filling the codified data matrix (<https://github.com/Pilacuan-Bonete-Luis/Company-Codification>), each of the economic, social, and environmental indicators was reported.

With the reports presented, a data matrix was constructed, where the study variables are the 100 indicators related to the GRI, while the analysis individuals are the 77 companies for 2020 and 73 for 2021.

2.2 Statistical Methods

The research structure is broken down into two parts; the first is based on describing the parameters used to decode the matrix and the representation of the variables as the classification of their size and activity utilizing bar and ring graphs. Then, in the second phase, the external logistic biplot method is implemented. Its interface enables the use and entry of dichotomous data, a crucial aspect for the analysis of indicators since the purpose is to validate the occurrence of "1" presence or "0" absence of the event [21].

To facilitate the ability to evaluate large data matrices' structure visually, we can use the Biplot method [22]. These allow us to visualize the data in a plane of smaller dimensions. Over time, this technique has presented several changes. Among these, we have the GH-Biplot, specifically designed to optimize the representation of variables (columns) and seek maximum quality in this aspect. In comparison, the JK-Biplot focuses on the representation of rows or individuals [23]. Subsequently, an extension of the biplot approach is proposed, giving rise to the HJ-Biplot proposed by Galindo, which seeks a greater simultaneous representation of rows and columns data matrix in a single two-dimensional plane [24] considering the introduction of quantitative data. However, in the context of binary data, it is evident that the method presents challenges. Subsequently, implementing the logistic biplot method [25] was suggested as a reliable alternative to multiple correspondence analysis for the case of presence and absence variables with binomial distribution. The external logistics biplot method implemented was suggested through the methodology proposed by Demey [26].

2.2.1 External Logistic Biplot Interpretation

The data have a multidimensional nature. Therefore, the Biplot method was chosen due to its usefulness compared to other methods since it can relate all the information in a single graph [27]. In addition, the logistic Biplot allows simplifying and analyzing the interpretation of complex data for columns and rows simultaneously [28]. The interpretation scheme follows a sequence of phases given by [26], as seen in the figure 1.

The data is processed using the MultBiplot software [29], and obtained (<http://biplot.usal.es/multbiplot/introduction.html>). The process begins with two data matrices with a dimension of n rows and p columns corresponding to the years subject to study. Then, principal components designed for binary data are analyzed. The objective is to achieve the ordering of these transformed data in an Euclidean space, using the Russell and Rao distance to measure the disparity between the points [30]. This metric considers weights for matches and non-matches.

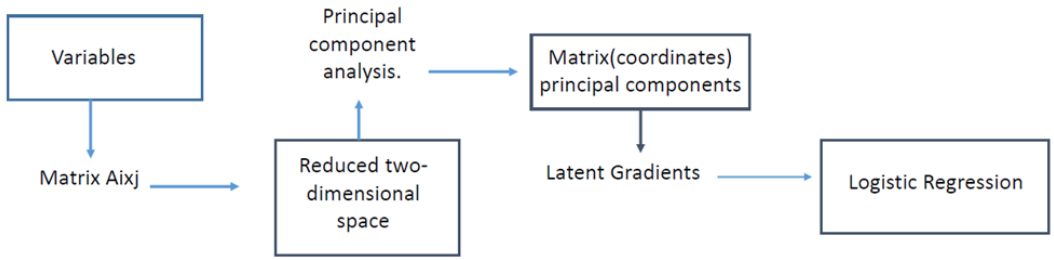


Figure 1. External Logistics Biplot Interpretation.

Furthermore, this point of similarity implies that, as the proximity between individuals (companies) in the resulting space is based on latent changes, their characteristics share a greater degree of equality. Another characteristic of this method is the ability to select the most representative ones for the logistic model in a set of variables. This guarantees an optimal quality of representation in the goodness settings; it is important to note that a high percentage reflects the similarity between the data and the original binary matrix. allowing the identification of the key dimensions that contribute significantly to the observed variability [31].

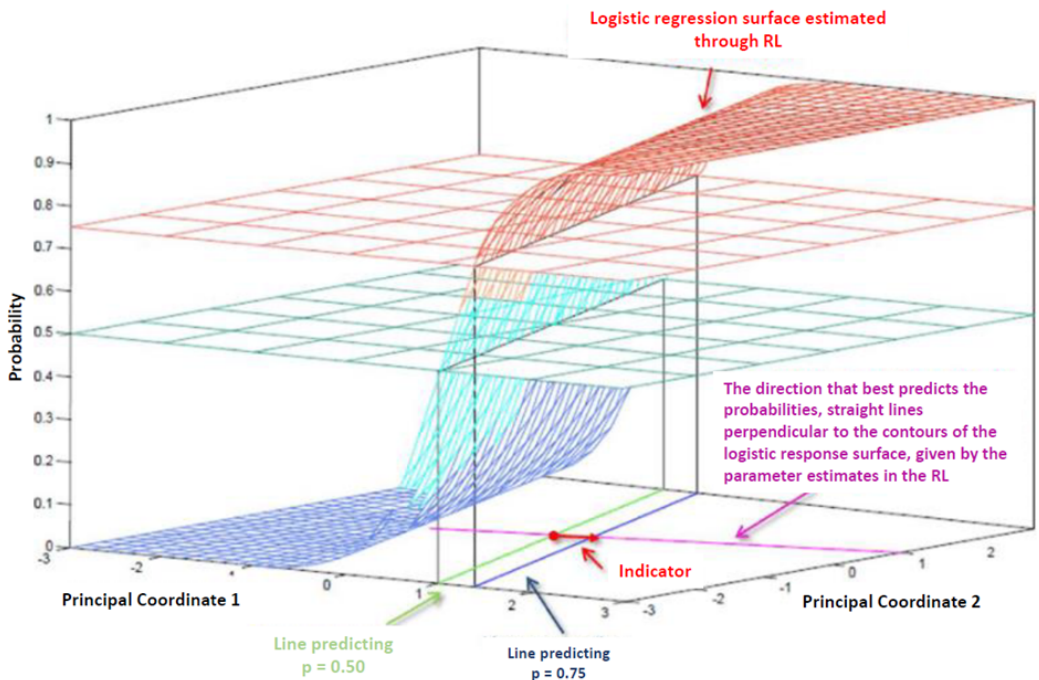


Figure 2. Geometry of the adjusted logistic response curve

In the subsequent stage, the transformed component variables are projected graphically as points (representative of companies) and vectors (indicators), according to the configuration previously outlined by the logistic regression model mentioned above. Specifically, selecting

parameters with p-values of less than 0.01 and that present an $R^2 > 0.59$ is advisable. This selection criterion aims to highlight the most significant variables, considering their explanatory capacity within the framework. Authors, such as Demey and Galindo [26], provide detailed descriptions of the fundamental elements for interpreting the biplot, observed figure 2.

These items include:

- The closeness between the points projected on the two-dimensional plane indicates their similarity based on their characteristics.
- The length of a vector provides a more precise distinction between companies; the shorter, the more functional, and vice versa.
- The variability of the data is reflected in its precision; greater variability means greater precision for the model.
- The application of the Ward clustering method for individual observations facilitates the formation of clusters with similar characteristics. The method seeks to minimize variance loss during clustering, contributing to a more precise and coherent grouping of companies according to their similarities.
- The probability of the presence or absence of an individual is illustrated by the direction it follows concerning the vector of the predictor variable (indicator).

3 Results

3.1 General report of sustainable reporting

Within the ranking prepared by the Superintendence of Companies for 2020 and 2021, an average of 111 894 active companies were found. Of these, only 103 companies presented their sustainability reports. 74 % were large companies, 20 % were medium-sized, and 6 % were small, suggesting a gap in sustainability reporting between different business categories.

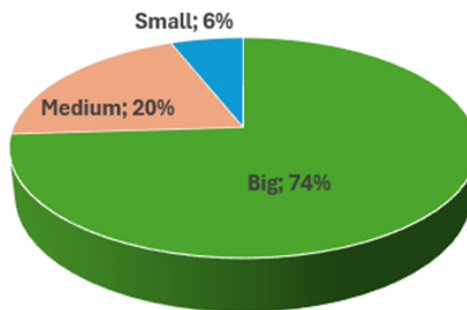


Figure 3. Size of Companies with Sustainable Reports in Ecuador

On Ecuador's geographic map, the provinces represented in shades of intense green indicate a greater number of reports. Pichincha leads with 47 reports, followed by Guayas with 43. In addition, reports are registered in Cotopaxi (3), Imbabura (2), and Manabi (2). Finally, the provinces of Azuay, Cañar, Galapagos, Loja, Tungurahua, and Zamora Chinchipe each have a report. This analysis reveals the distribution of sustainability reports in different regions of the country.

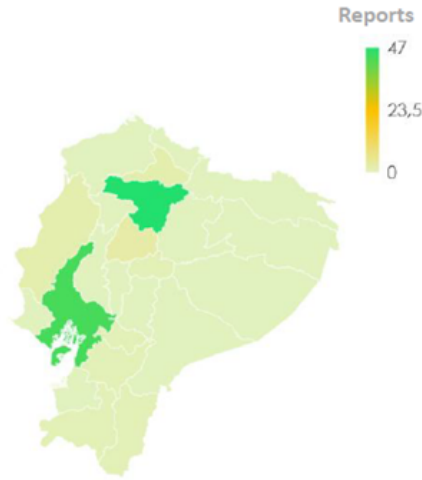


Figure 4. Reports in different regions in Ecuador

3.2 Gradual Results 2020

In the first two-dimensional representation using an external logistic biplot figure 5, you can see the global adjustment index, which shows a percentage of 81.91 %, indicating a correct rating in the biplot. The analyzed variables related to the GRI (social (fuchsia), economic (purple), and Environmental (green)) are represented by vectors of different colors, as well as the analyzed companies represented with red dots distributed in the quadrants.

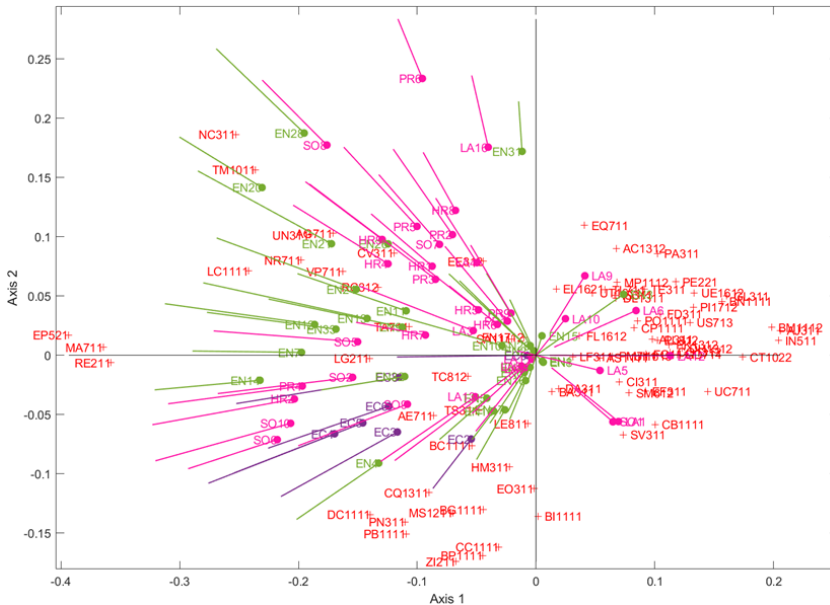


Figure 5. Biplot Logistic Extern 2020. Adjustment 81.91%

Table 1. The Goodness of Fit for GRI Sustainability Indicators Year 2020

Indicator	Deviation	p-value	R2	% Correct
Economic consequences and other risks and opportunities for the organization’s activities arising from climate change (EC2)	45.088	0	0.632	83.117
Energy intensity is used for operations (EN5)	48.571	0	0.637	87.013
Indirect greenhouse gas emissions (EN16)	52.613	0	0.676	81.818
Other indirect greenhouse gas emissions (EN17)	45.13	0	0.615	80.519
Greenhouse gas emissions intensity (EN18)	81.041	0	0.852	90.909
Reduction of greenhouse gas emissions (EN19)	45.978	0	0.605	79.221
Percentage of security personnel who have received training on the organization’s human rights policies or procedures relevant to operations (HR7)	47.16	0	0.66	87.013
Number of cases of violation of the rights of indigenous peoples and measures adopted (HR8)	35.063	0	0.613	92.208

Table 2. Cosine of angles and factorial axes year 2020

Indicator	Axis 1	Axis 2	Gradient
EC2	-0.6111	-0.7915	2
EN5	-0.7524	-0.6587	1
EN16	-0.3779	-0.9259	2
EN17	-0.4942	-0.8694	2
EN18	-0.6041	-0.7969	2
EN19	4-0.4436	-0.8962	2
HR7	-0.9837	0.1800	1
HR8	-0.4852	0.8744	2

The percentage of classification accuracy for each variable exceeds 79%, indicating a remarkably high predictive capacity of these variables. Therefore, it is considered satisfactory.

The most significant indicators are provided below, detailed in Table 1, which have been chosen according to specific criteria for this study, with an $R^2 > 0.59$ and a $p\text{-value} < 0.01$.

Table 2 shows the contribution of the main sustainability indicators analyzed with their respective factor axes and the cosine of the calculated angle, which allows determining to which gradient the indicator has the greatest contribution.

To determine the direction of the sustainability gradient, the contribution of each axis was added, revealing that both axis 1 (X) and axis 2 (Y) have a negative weight. On the other hand, when looking at the locations of the companies (points) within the image, it is noted that the direction followed by the sustainability gradient shows a lower propensity for sustainability reporting compared to Quadrants I and IV. It is important to mention that all indicators have a coefficient of determination (R^2) greater than "0.59", indicating that the model is solid.

In the figure 6 representation of the biplot of the external logistic model for the year 2020, specific data related to social (fuchsia), economic (purple), and Environmental indica-

tors (green) were examined. Observation reveals that two quadrants reflect these indicators. According to the results, 6 indicators within quadrant III and 2 indicators within quadrant II stand out. Regarding the relationship of the axes, it is observed that most indicators show a strong negative correlation with axis 1. Regarding axis 2, a moderate degree of indicators that tend towards a negative correlation can be seen. However, it is important to highlight that HR7 (Percentage of security personnel who have received training) and HR8 (Number of cases of violation of the rights of indigenous people and measures adopted) exhibit a positive correlation with this axis.

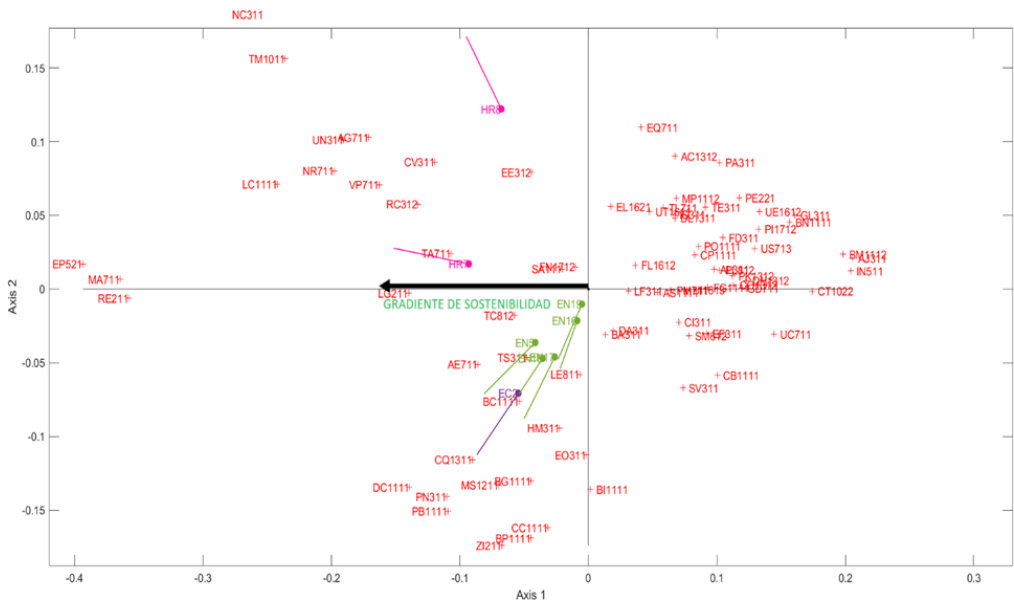


Figure 6. Main Indicators of the External Logistics Biplot of 2020.

In figure 6, you can see how the indicators are positioned to the companies analyzed in 2020. According to the indicators described in Table 1, you can see how the sustainability gradient moves. The figure shows how the HR7 indicator has a high probability of presence in the companies in quadrant II, where it is observed how LC1111 (Cooperativa De Ahorro y Crédito Lucha Campesina) has a high probability of presence of the indicator. Likewise, if it is projected, the indicator in quadrant IV shows that these companies have a high probability of absence, like CB1111(CHUBB).

To understand the analysis of the projections, we consider the EN18 indicator, which has a certain R2 coefficient of 0.8516. Figure 7 shows the projection of the EN18 indicator, as well as the projections of the companies about this indicator, where it is observed that the solid lines represent the presence of indicator "1" in the companies. In contrast, the dashed lines indicate its absence with "0". In this context, it is observed that 16 companies have reported this indicator, while the rest have not made such a report.

Considering the environmental indicator EN18, which addresses the intensity of greenhouse gas emissions, when examining this parameter from an alternative perspective and graphically representing it in terms of presence and absence by region, we observe in figure 8 that 16 companies are located in the fuchsia region, indicating that they have reported said indicator. On the other hand, the other 61 companies are located in the celestial region, point-

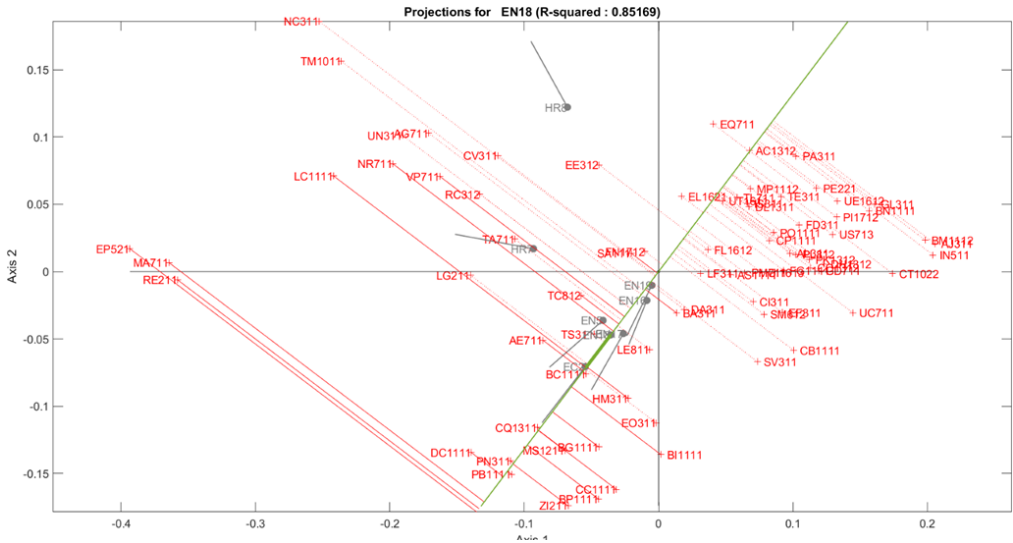


Figure 7. Indicator Projection EN18.

ing out the lack of reporting in this aspect. Notably, 5 companies, highlighted in red, were classified in the absence region, while another 3 are on the perpendicular prediction line.

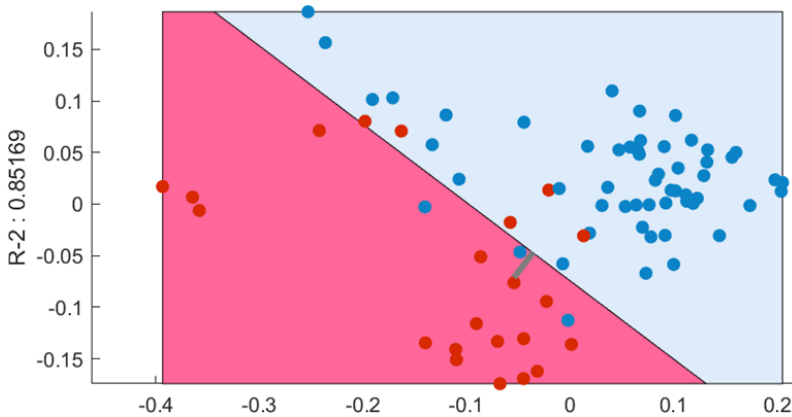


Figure 8. Prediction region Indicator EN18.

Using the scores derived from the Logistic Biplot, Ward’s hierarchical clustering method is used in figure 9. This approach evaluates the distance between individuals and groups based on their similarities. Cluster 4 stands out as the most significant, composed of 46 companies, representing a percentage of 59.74%. It is followed by cluster 3, comprised of 17 companies, which constitutes 22.07% of the total. Furthermore, cluster 2 comprises 11 companies, representing 14.28%, while cluster 4 has a lower percentage, reaching 3.89%.

Table 3. The Goodness of Fit for GRI Sustainability Indicators Year 2021

Indicator	Deviation	p-value	R2	% Correct
Reduction of energy requirements of products and services (EN7)	36,158	1,81E-09	0,614	91,78
Greenhouse gas emissions intensity (EN18)	44,423	2,64E-11	0,618	79,45
Significant environmental impacts of the transportation of products and other goods and materials used for the organization’s activities, as well as the transportation of personnel (EN30)	20,644	5,53E-06	0,869	98,63
Percentage of workers represented on formal joint management employee health and safety committees established to help monitor and advise on occupational health and safety programs (LA5)	46,728	8,15E-12	0,626	79,45
Workers with high incidence or high risk of diseases related to their activity (LA7)	49,939	1,58E-12	0,658	84,93
Number and percentage of significant investment contracts and agreements that include human rights clauses or that have been subject to human rights analysis (HR1)	34,316	4,68E-09	0,606	90,41
Identification of significant facilities and suppliers where freedom of association and the right to benefit from collective agreements may be violated or threatened, and measures are taken to defend these rights (HR4)	38,741	4,83E-10	0,641	89,04
Number of cases of violation of the rights of indigenous peoples and measures adopted (HR8)	32,791	1,02E-08	0,635	91,78

satisfactory. Figure 10 shows the global results of the external logistics biplot for the 2021 period of Ecuadorian companies concerning the GRI sustainability indicators.

The indicators seen in Table 3 exhibit a variety of relationships with both axes. For example, reducing energy requirements for products and services (EN7) shows a moderately positive correlation with Axis 1 and a strong negative correlation with Axis 2. In contrast, Greenhouse gas emissions intensity (EN18) shows a strong positive correlation with both axes. Significant environmental impacts of the transportation of products and other goods and materials used for the organization’s activities and the transportation of personnel (EN30), in contrast, present a weak or null correlation with both axes. Indicators Percentage of workers represented on formal joint management-employee health and safety committees established to help monitor and advise on occupational health and safety programs (LA5) and Workers with high incidence or high risk of diseases related to their activity (LA7) reveal a moderately negative correlation with both axes. In contrast, the number and percentage of significant investment contracts and agreements that include human rights clauses or have been subject to human rights analysis (HR1) shows a moderately positive correlation with Axis 1 and a

Table 4. Cosine of angles and factorial axes year 2021

Indicator	Axis 1	Axis 2	Gradient
EN7	0,410	-0,911	2
EN18	0,903	0,429	1
EN30	-0,00091	-0,999	2
LA5	-0,476	-0,879	2
LA7	-0,381	-0,924	2
HR1	0,575	-0,817	2
HR4	0,908	-0,417	1
HR8	0,711	-0,703	1

strong negative correlation with Axis 2. Identification of significant facilities and suppliers where freedom of association and the right to benefit from collective agreements may be violated or threatened and measures taken to defend these rights (HR4), on the other hand, presents a strong positive correlation with Axis 1 and a weak negative correlation with Axis 2. Finally, the number of cases of violation of the rights of indigenous peoples and measures adopted (HR8) exhibits a moderately positive correlation with both axes.

Table 4 shows the contribution of the main sustainability indicators analyzed with their respective factor axes and the cosine of the angle calculated for 2021, allowing us to observe the gradient to which the indicator has the greatest contribution.

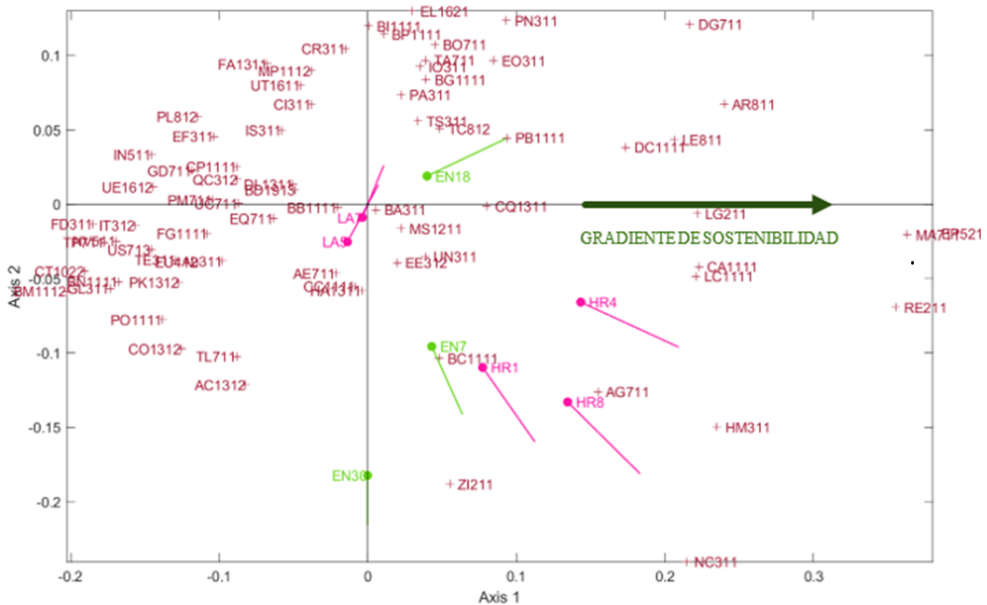


Figure 11. Main Indicators of the External Logistics Biplot of 2021.

In 2021, it is observed that among the three categories evaluated: economic, environmental, and social, the social dimension is the most prominent. Within this dimension, indicators HR4 and HR8 show a strong relationship with positive axis 1, while indicators LA5 and LA7 tend towards the positive side of axis 2 and HR1 towards the negative side.

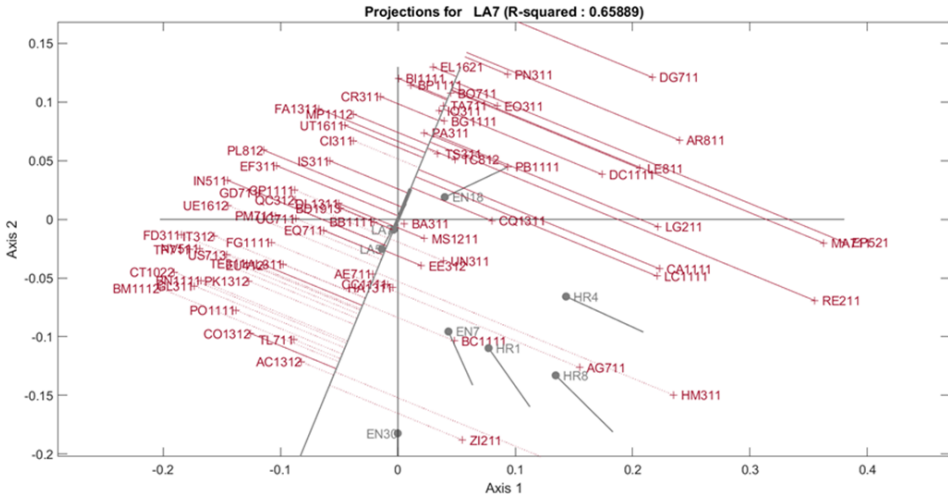


Figure 12. Indicator Projection LA7.

The second relevant category is environment, where the EN7 and EN30 indicators lean towards the negative axis of axis 2. In contrast, the EN18 indicator shows a more favorable relationship with the positive side of axis 1. To obtain the sustainability gradient, the contributions of each axis, it is notable that the greatest weight is found on the positive side of axis 1, which implies a predominant direction towards that axis, attributing to the fact that the points (companies) that are in that direction have a greater propensity to report their sustainable reports, another characteristic that can be seen in quadrant IV is the concentration of indicators, as seen in the figure 11. It is important to emphasize that all of them have a coefficient of determination (R²) greater than "0.59", indicating that the model is solid. For

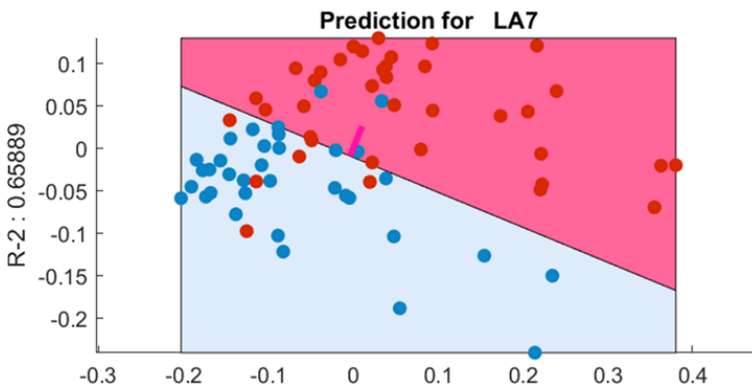


Figure 13. Prediction region Indicator LA7.

2020, the projections by indicator for 2021 can be interpreted as follows: The solid lines denote the presence of the indicator "1" within the companies, while the dashed lines indicate its absence with "0."

For example, consider the social indicator LA7, figure 12, which focuses on workers with a high incidence or risk of diseases due to their jobs. When analyzing this indicator from a different perspective, we can see in the figure 13 of presence and absence by region that 38 companies are located in the fuchsia region, which indicates that they have reported said indicator, while the other 65 companies are located in the region light blue, indicating its absence of report in this regard. However, 5 companies, marked in red, were classified in the absence region, and 2 are on the perpendicular prediction line

4 Discussion and Conclusions

The report reveals that only 0.09% of active companies in Ecuador submitted sustainability reports for the years 2020 and 2021. This low level of participation suggests a significant gap in sustainability disclosure between different categories of companies, with large companies leading the way in reporting. This lack of disclosure may indicate a lack of awareness or commitment to sustainable practices in small and medium-sized businesses.

The analysis shows a uniform distribution of sustainability reports in the provinces of Pichincha and Guayas, which leads to the number of reports. This concentration may reflect a greater awareness and commitment to sustainability in these regions, or be influenced by economic and regulatory factors specific to each province or region.

It can be seen how the external logistics Biplot is a tool that has allowed us to analyze the complex relationships of sustainability indicators according to the GRI reported by Ecuadorian companies during 2020 and 2021. The evaluated indicators show a remarkably high predictive capacity in both years, with classification accuracy percentages greater than 79%. The economic, environmental, and social indicators showed different degrees of correlation with the axes of the external logistic model. This indicates that the selected variables effectively predict and evaluate the complex relationships of sustainability in different sectors and regions. In 2020, greenhouse gas emissions and human rights indicators showed the strongest correlations. In 2021, the social dimension emerged as the most prominent, with indicators related to human rights showing strong positive correlations with axis 1.

Indicators HR4, HR8, EN18, and EN30 emerge as particularly relevant, revealing significant relationships with sustainability's social and environmental dimensions. The focus on social and environmental dimensions is evident in the results of both years. The social dimension shows growing relevance, with indicators such as HR4 and HR8 standing out for their strong positive correlation. This underlines the importance of considering social aspects in the sustainability agenda, such as labor rights and employee well-being. The environmental dimension also plays a crucial role, with indicators such as EN18 and EN30 revealing the need to address issues such as greenhouse gas emissions and sustainable resource management. These findings highlight the importance of adopting sound environmental practices and policies to mitigate negative environmental impacts.

Companies, especially medium and small businesses, must enhance their commitment to sustainable practices and disclosure to address environmental, social, and economic challenges and take advantage of emerging market opportunities. To move towards a more sustainable economy, Ecuadorian companies must increase their commitment to sustainable practices and improve sustainability disclosure, addressing identified challenges and taking advantage of opportunities for continuous improvement. The results provide a solid basis for making informed decisions regarding sustainability in Ecuador. Although significant progress is being made in reporting and commitment to sustainability, challenges, and areas of opportunity still require attention and strategic action. It is recommended to continue strengthening awareness-raising, training, and support initiatives at the national level, focusing on

underrepresented areas and integrating social and environmental dimensions in sustainability strategies.

Acknowledgment

The project “Regional Observatory Of The Sustainable Development Goal 9 Industry, Innovation, and Infrastructure” has partially supported this research (FCI-081-2023) of the University of Guayaquil.

References

1. E. Urteaga, Las teorías económicas del desarrollo sostenible, Cuadernos de Economía **32**, 113 (2009). [10.1016/S0210-0266\(09\)70051-2](https://doi.org/10.1016/S0210-0266(09)70051-2)
2. M.R. Perello-Marin, R. Rodríguez-Rodríguez, J.J. Alfaro-Saiz, Analysing GRI reports for the disclosure of SDG contribution in European car manufacturers, Technological Forecasting and Social Change **181**, 121744 (2022). [10.1016/J.TECHFORE.2022.121744](https://doi.org/10.1016/J.TECHFORE.2022.121744)
3. H. Brundtland, Tech. rep., Naciones Unidas (1987)
4. M.d.M. Alonso-Almeida, F. Marimon, J. Llach, Difusión de las memorias de sostenibilidad en Latinoamérica: análisis territorial y sectorial, Estudios Gerenciales pp. 139–149 (2015). [10.1016/j.estger.2015.01.002](https://doi.org/10.1016/j.estger.2015.01.002)
5. J. Polanco, F. Ramírez, M. Orozco, Incidencia de estándares internacionales en la sostenibilidad corporativa: una perspectiva de la alta dirección, Estudios Gerenciales **32**, 181 (2016). <https://doi.org/10.1016/j.estger.2016.05.002>
6. H. Gutiérrez-Ponce, Sustainability as a strategy base in Spanish firms: Sustainability reports and performance on the sustainable development goals, Sustainable Development **31**, 3008 (2023). [10.1002/SD.2566](https://doi.org/10.1002/SD.2566)
7. J. Carro-Suárez, S. Sarmiento-Paredes, G. Rosano-Ortega, La cultura organizacional y su influencia en la sustentabilidad empresarial. La importancia de la cultura en la sustentabilidad empresarial, Estudios Gerenciales **33**, 352 (2017). <https://doi.org/10.1016/j.estger.2017.11.006>
8. Y. Höller, M.M. Urbschat, A. Bathke, Sustainable scientific publishing: a pilot survey on stakeholder motivations and opinions, Discover Sustainability **5**, 1 (2024). [10.1007/s43621-023-00175-1](https://doi.org/10.1007/s43621-023-00175-1)
9. A.M.A. AL-Janabi, M.J. Saei, R. Hesarzadeh, The Impact of Adherence to Sustainable Development, as Defined by the Global Reporting Initiative (GRI-G4), on the Financial Performance Indicators of Banks: A Comparative Study of the UAE and Iraq, Journal of Risk and Financial Management **17**, 17 (2024). [10.3390/jrfm17010017](https://doi.org/10.3390/jrfm17010017)
10. R. Lozano, D. Huisingh, Inter-linking issues and dimensions in sustainability reporting, Journal of Cleaner Production **19**, 99 (2011). [10.1016/j.jclepro.2010.01.004](https://doi.org/10.1016/j.jclepro.2010.01.004)
11. C. Kuzey, A. Uyar, Determinants of sustainability reporting and its impact on firm value: Evidence from the emerging market of Turkey, Journal of Cleaner Production **143**, 27 (2017). [10.1016/J.JCLEPRO.2016.12.153](https://doi.org/10.1016/J.JCLEPRO.2016.12.153)
12. C. Mio, Corporate social reporting in Italian multi-utility companies: An empirical analysis, Corporate Social Responsibility and Environmental Management **17**, 247 (2010). [10.1002/CSR.213](https://doi.org/10.1002/CSR.213)
13. J.A. Martínez-Regalado, C.L. Murillo-Avalos, P. Vicente-Galindo, M. Jiménez-Hernández, J.L. Vicente-Villardón, Using HJ-Biplot and External Logistic Biplot

- as Machine Learning Methods for Corporate Social Responsibility Practices for Sustainable Development, *Mathematics* 2021, Vol. 9, Page 2572 **9**, 2572 (2021). 10.3390/MATH9202572
14. L.R. Ferrada, M. Vega, J.A. Orozco-Toro, C. Ávila, The sdgs in sustainability reports among companies in ecuador, colombia, and chile, *Contratexto* pp. 117 – 147 (2023). 10.26439/contratexto2023.n40.6440
 15. A. Polibio Martínez, J. Jara-Alvear, R.J. Andrade, D. Icaza, Sustainable development indicators for electric power generation companies in Ecuador: A case study, *Utilities Policy* **81**, 101493 (2023). 10.1016/j.jup.2023.101493
 16. J. Mira, V. Pérez-Jover, S. Lorenzo, J. Aranaz, J. Vitaller, La investigación cualitativa: una alternativa también válida, *Atención Primaria* **34**, 161 (2004). 10.1016/S0212-6567(04)78902-7
 17. N. Mays, C. Pope, Rigour and qualitative research, *British Medical Journal* **311**, 109 (1995). 10.1136/BMJ.311.6997.109
 18. M. Blázquez, M.F. Peretti, Modelo para gestionar la sustentabilidad de las organizaciones a través de la rentabilidad, adaptabilidad e imagen, *Estudios Gerenciales* **28**, 40 (2012). 10.1016/S0123-5923(12)70006-2
 19. Global Reporting Initiative, Tech. rep., Amsterdam (2006)
 20. O. González-Morales, I. Galván-Sánchez, C. Román-Cervantes, Social responsibility as a source of satisfaction for worker-members in a social economy transport company, *Research in Transportation Business & Management* **51**, 101070 (2023). 10.1016/J.RTBM.2023.101070
 21. S.A. Dominguez Lara, ¿Ítems Politémicos o Dicotómicos? Un estudio empírico con una escala unidimensional , *Revista Argentina de Ciencias del Comportamiento (RACC)* **5**, 30 (2013).
 22. K.R. GABRIEL, The biplot graphic display of matrices with application to principal component analysis, *Biometrika* **58**, 453 (1971). 10.1093/biomet/58.3.453
 23. A. Nieto, Ph.D. thesis, UNIVERSIDAD DE SALAMANCA, Salamanca, Spain (2013)
 24. P. Galindo, Un alternativa de representación simultánea: HJ-Biplot., *Qüestió* **10**, 13 (1986).
 25. J.L. Vicente Villardón, Ph.D. thesis, University of Salamanca, Spain (1992)
 26. J.R. Demey, J.L. Vicente-Villardón, M.P. Galindo-Villardón, A.Y. Zambrano, Identifying molecular markers associated with classification of genotypes by External Logistic Biplots, *Bioinformatics (Oxford, England)* **24**, 2832 (2008). 10.1093/BIOINFORMATICS/BTN552
 27. S.Y. Enciso-Alfaro, V. Amor-Esteban, T.C. Azevedo, I.M. García-Sánchez, Multivariate Analysis of Clean Technologies in Agricultural and Livestock Companies in Castilla y León, *Agriculture (Switzerland)* **13**, 2087 (2023). 10.3390/agriculture13112087
 28. I. Gallego-Álvarez, J.L. Vicente-Villardón, Analysis of environmental indicators in international companies by applying the logistic biplot, *Ecological Indicators* **23**, 250 (2012). <https://doi.org/10.1016/j.ecolind.2012.03.024>
 29. J.L. Vicente Villardón, Introducción | MultiBiplot | José Luis Vicente Villardón (2009), <http://biplot.usal.es/multbiplot/introduction.html>
 30. Z.E. Chay, C.H. Lee, K.C. Lee, J.S. Oon, M.H. Ling, Russel and Rao Coefficient is a Suitable Substitute for Dice Coefficient in Studying Restriction Mapped Genetic Distances of *Escherichia coli* (2023).
 31. T. Wang, F. Zhang, H. Gu, H. Hu, M. Kaur, A research study on new energy brand users based on principal component analysis (PCA) and fusion target planning model for sus-

tainable environment of smart cities, Sustainable Energy Technologies and Assessments
57, 103262 (2023). 10.1016/J.SETA.2023.103262