



Analysis of The Distribution and Impact of Scholarships in the Higher education of Ecuador.

Análisis de la Distribución e Impacto de las Becas en la Educación Superior de Ecuador.

Iván Patricio Montaleza Quizhpe ^{1,2} and Franklin Parrales-Bravo ^{3,4}

¹ Bolivarian University of Ecuador, Durán, Guayas, Ecuador, ipmontalezaq@ube.edu.ec

² Universidad Técnica Particular de Loja, Loja, Loja, Ecuador; ipmontaleza@utpl.edu.ec

³ Bolivarian University of Ecuador, Duran, Guayas, Ecuador.

⁴ Universidad de Guayaquil, Guayas, Ecuador.

Abstract. This analysis examines the distribution and influence of the scholarships in the higher education in Ecuador during the period 2020-2024, using a publicly accessible database. Its main objective was to analyze how the scholarships were assigned based on various factors: level of training (postgraduate, undergraduate, technical/technological), geographic location (province), gender, ethnicity and disability status of the beneficiaries. methodology The data collection process was rigorous and transparent. Orange software was used for the collection and treatment previous of the data, and Power BI for the representation visual of the results. The statistical analysis was descriptive, including frequencies and percentages, as well as the creation of various graphs to represent the results. The findings show a pronounced trend towards an increase in the total number of scholarship recipients in the years following 2020, with a main emphasis on scholarships for third-level Higher Technical and Higher Technological courses. The geographical location of the scholarship recipients reveals notable concentrations in the province of Guayas, despite differences by sex and ethnicity. Additionally, a prevalence of scholarship recipients with physical disabilities is detected, followed by visual disabilities and then visual disabilities.

Keywords: scholarships; education superior; Ecuador; disability; ethnicity; inclusion.

Resumen. Este análisis examina la distribución e influencia de las becas en la educación superior en Ecuador durante el período 2020-2024, utilizando una base de datos de acceso público. Su principal objetivo fue analizar cómo se asignaron las becas en función de varios factores: nivel de formación (posgrado, pregrado, técnico/tecnológico), ubicación geográfica (provincia), género, etnia y condición de discapacidad de los beneficiarios. metodología El proceso de recolección de datos fue riguroso y transparente. Se utilizó el software Orange para la recogida y tratamiento previo de los datos, y Power BI para la representación visual de los resultados. El análisis estadístico fue descriptivo, incluyendo frecuencias y porcentajes, así como la creación de diversos gráficos para representar los resultados. Los resultados muestran una marcada tendencia al aumento del número total de becarios en los años posteriores a 2020, destacando principalmente las becas para estudios de Técnico Superior de tercer nivel y Tecnológico Superior. La ubicación geográfica de los becarios revela notables concentraciones en la provincia del Guayas, a pesar de las diferencias por sexo y etnia. Adicionalmente, se detecta una prevalencia de becarios con discapacidad física, seguido de discapacidad visual y luego discapacidad visual.

Palabras clave: becas; educación superior; Ecuador; discapacidad; etnia; inclusión.

1. Introduction

University education plays a crucial role in a nation's socioeconomic progress (UNESCO, 2019). Equitable access to it, promoted by scholarship programs, is essential to reduce inequalities and encourage social mobility (World Bank, 2020). In Ecuador, scholarship strategies aim to ensure that students from different backgrounds and with

varied financial needs can access and complete their university studies (SENESCYT, 2023) [1].

This analysis examines the distribution and influence of scholarships in university education in Ecuador, using information updated until December 2024 [2]. The analysis is carried out using data analysis and visualization tools, pursuing a rigorous and clear method. The main purpose is to detail the allocation of scholarships according to the level of education, geographic location (province), gender, ethnicity, and disability status of the beneficiaries [3].

The implementation of scholarship programs in Ecuador has undergone significant evolution since the educational reforms initiated in 2008 with the new Constitution, which established the gratuity of public higher education. This transformation has gone through various stages of institutional development, modifying its selection criteria, allocated amounts, and target populations. The study of these dynamics is fundamental to understanding how public educational policies have responded to the changing needs of Ecuadorian society and the national development objectives established in successive government plans, particularly in relation to the reduction of socioeconomic gaps and the promotion of talents in strategic areas for the country.

Additionally, the Latin American context offers a relevant comparative framework for this analysis, considering that the region has faced similar challenges in terms of equitable access to higher education. The experiences of countries such as Chile, Brazil, and Colombia with their respective scholarship systems provide valuable reference points for evaluating the effectiveness of the Ecuadorian model. Particularly important is analyzing how scholarship policies have managed or failed to counteract the effects of historical structural inequalities, especially those related to ethnic-racial, geographic, and socioeconomic factors. This comparative analysis allows the identification of good practices and opportunities for improvement in the implementation of scholarship programs, thus contributing to the design of more effective and contextualized policies for the Ecuadorian environment.

2. Materials and Methods

For this study HE used the "Base of data of scholarships updated December 2024" downloaded of the Open data website of the Government of Ecuador (Government of Ecuador, 2024) (<https://www.datosabiertos.gob.ec/>) [4]. The base of data contained information detailed about the interns in the period 2020-2024, including:

Education level: Postgraduate, undergraduate, technical/technological. Distribution by year: 2020, 2021, 2022, 2023, 2024.

Distribution by province: Data of all the interns by province. Gender: Female and male.

Disability: Auditory, physics, intellectual, language, psychological, psychosocial and visual. **Ethnicity:** Afro-descendant , white, indigenous, mestizo, montubio, mulatto and No registered.

2.1. Harvest and Preprocessing of Data

The base of data in format CSV was collected and preprocessed using the tool of mining from **Orange** open source data (**Demsar et al., 2013**) . Orange allowed:

The import and the cleaning of the data.

The transformation of variables for ease he analysis. Handling missing values.

The selection of the variables of interest for he study.

2.2. Display of Results

For the display and analysis exploratory of the results HE used **Power BI (Microsoft, 2024)**. This business intelligence tool allowed us to create:

Tables and graphics interactive.

Views that facilitated the ID of patterns and tendencies in the data.

2.3. Statistical Analysis

HE performed a analysis descriptive of the data for grasp the distribution of the scholarships. This analysis included:

Frequencies and percentages: For he level of training, the distribution annual, the distribution by province, by gender, type of disability and ethnicity.

Views: HE They used graphics of bars, graphics of cake and tables for represent the key trends and patterns

observed in the data generated by Power BI.

3. Results

The results allow us to determine a notable increase in the total number of scholarship holders from 2020, reaching a total of 18,376 interns for the period 2020-2024. Besides, the level technical/technological It was the one that concentrated the largest number of scholarships (13,209), followed by the postgraduate (3,039) and undergraduate (2,128) levels. Likewise, in 2023 the highest number of scholarship recipients was recorded, especially at the technical/technological level. This can be seen in Table 1.

Table 1 – Total of interns by year and by level of training

LEVEL OF EDUCATION	2020	2021	2022	2023	2024	TOTAL
POSTGRADUATE	0	49	1155	1835	0	3039
UNDERGRADUATE	1	49	689	1389	0	2128
TECHNICAL / TECHNOLOGICAL	259	1	1240	9562	2147	13209
TOTAL	260	99	3084	12786	2147	18376

The results found in the distribution of scholarships by province and by gender determined that the province of Guayas had the highest number of scholarship recipients (5,822), followed by Pichincha (1,496) and Los Ríos (1,015). Level gender, a greater was observed proportion of female compared to male interns (11,150 women vs. 6,676 men). These differences are not are uniform across all provinces. Figure 1 shows the distribution of scholarships by province, broken down by gender.

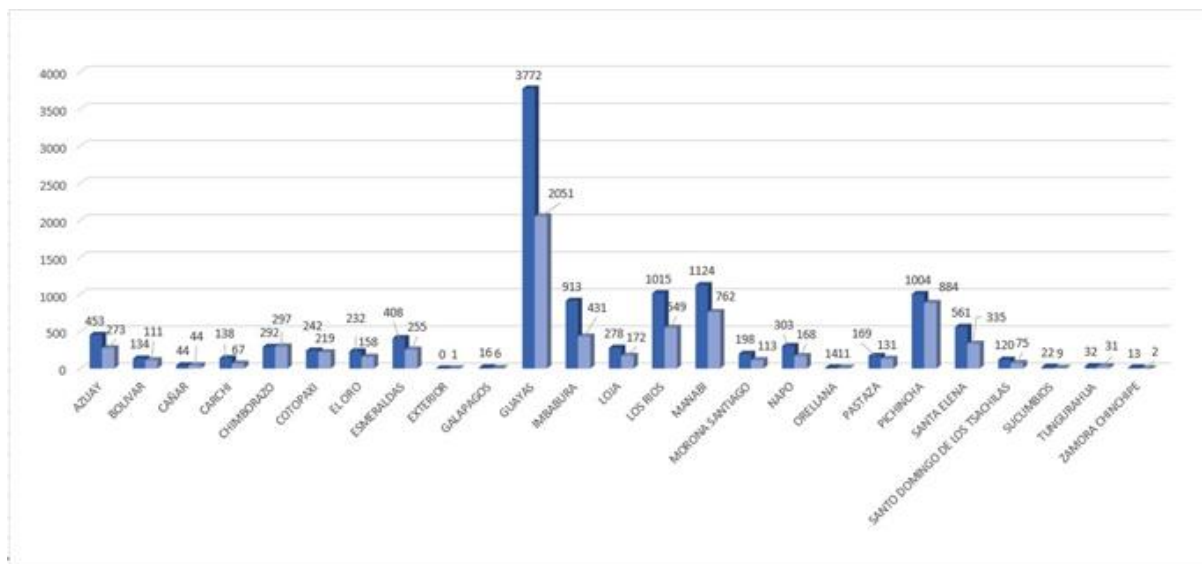


Figure 1 – Distribution of scholarships by province, broken down by gender.

Scholarship holders with physical disabilities represent 41% of the total, followed by visual disabilities (21%) and auditory (16%). The disabilities: intellectual, of the language, psychological and psychosocial represent proportions minors. He detail of all the interns with disabilities is shown in Figure 2.

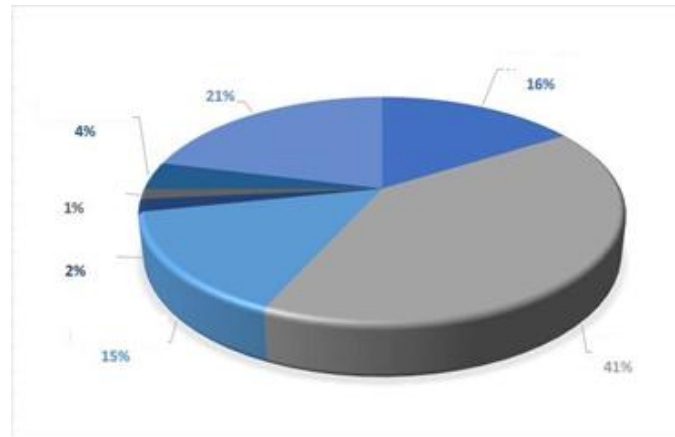


Figure 2 – Total of interns with disability.

According to the groups ethnic, he 77% of the Fellows identify themselves as mestizos, he 9% of the Scholarship recipients are indigenous, 8% Montubio and 4% Afro-descendants . The remaining 1% are divided between mulattoes and whites. Figure 3 shows the percentage of scholarship recipients by ethnicity.

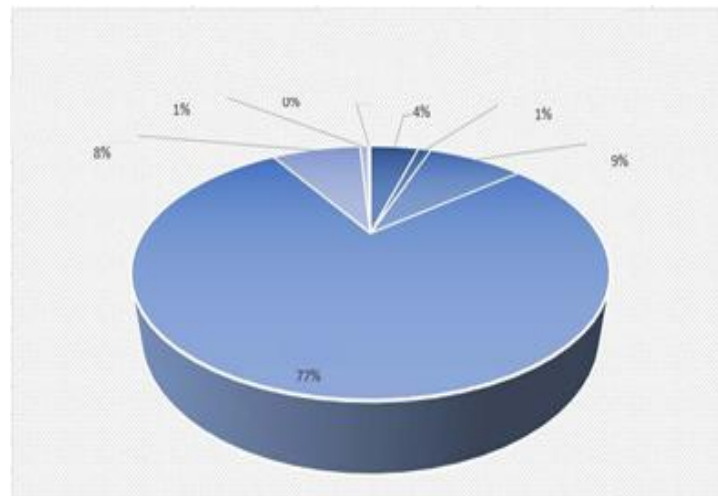


Figure 3 – Percentage of interns by ethnicity.

3.1. Validation of the Method Used in the Research: Evaluation of Orange Data Mining and Power BI Using a Neutrosophic Multicriteria Analysis

Orange Data Mining and **Power BI** is validated as the main methods for analyzing data on scholarships in Ecuador, using the **Scholarship Database updated December 2024** obtained from the open data website of the Government of Ecuador (<https://www.datosabiertos.gob.ec/>) [12-15]. To do this, a **neutrosophic multicriteria analysis** is applied , which allows evaluating the robustness, precision and applicability of these tools in handling data with uncertainty and imprecision. Next, the validation of the method is presented, highlighting its use and effectiveness in the research context.

1. Justification for the Use of Orange Data Mining, Power BI and Neutrosophic Analysis

a. Orange Data Mining and Power BI as Main Tools:

- **Orange Data Mining** is a data analysis and visualization platform that allows you to build workflows for data processing, analysis and visualization. Its graphical interface and its ability to integrate data mining, machine learning and visualization techniques make it an ideal tool for quantitative and descriptive research.
- **Power BI** is a business intelligence tool that allows you to create interactive visualizations and advanced analysis. Its ability to integrate with multiple data sources and generate dynamic reports makes it easy to identify patterns and trends.
- In this study, Orange Data Mining is used for preprocessing and initial analysis of the data, while Power BI is used for visualization and exploratory analysis of the results.
- **Neutrosophic Multicriteria Analysis[16-19] :**
- Since scholarship data may present uncertainty (for example, in the distribution by province or in the categorization of disabilities), a neutrosophic analysis is applied to evaluate the capacity of these tools in managing this uncertainty.
- Neutrosophic logic allows the incorporation of degrees of truth, falsehood and indeterminacy, which reinforces the evaluation of tools in complex contexts.

2. Data Generation and Application of Orange Data Mining and Power BI

a. Data Used:

- **Scholarship Database updated December 2024** is used, which contains detailed information on scholarship recipients in the period 2020-2024, including:
- Education level: Postgraduate, undergraduate, technical/technological.
- Distribution by year: 2020, 2021, 2022, 2023, 2024.
- Distribution by province: Data on all scholarship holders by province.
- Gender: Female and male.
- Disability: Hearing, physical, intellectual, language, psychological, psychosocial and visual.
- Ethnicity: Afro-descendant, white, indigenous, mestizo, montubio, mulatto and unregistered.

b. Processing with Orange Data Mining:

- **Preprocessing:** Orange's preprocessing module is used to clean the data, handle missing values, and normalize the variables.
- **Descriptive Analysis:** Widgets such as " Distributions " and "Box Plot " are used to visualize the distribution of scholarship recipients by training level, year, province, gender, disability and ethnicity.
- **Clustering:** Clustering techniques (e.g., k- means) are applied to identify groups of scholarship recipients with similar characteristics.
- **Display:** Widgets such as " Scatter" are used Plot and Heatmap to visualize relationships between variables and patterns in the data.
- **Visualization with Power BI:**
- **Interactive Tables and Graphs:** Create interactive tables and graphs that make it easy to identify patterns and trends in your data.
- **Visualizations:** Bar charts, pie charts, and tables are used to represent key trends and patterns observed in the data.

c. Transformation of Data to Neutrosophic Intervals:

- To assess uncertainty in the data, the results obtained with Orange Data Mining and Power BI are transformed into neutrosophic intervals. For example:
- **Distribution by Level of Education:** Between 30% and 35% of scholarship recipients have a 70% chance of being at the undergraduate level, with 15% of uncertainty.
- **Distribution by Province:** Pichincha has between 25% and 30% of the scholarship holders, with a degree of truth of 75%, a degree of falsity of 15% and a degree of indeterminacy of 10%.

3. Neutrosophic Multicriteria Evaluation of Orange Data Mining and Power BI

a. Criteria Evaluated:

- **Criterion 1:** Accuracy in data analysis.
- **Criterion 2:** Ability to manage uncertainty.
- **Criterion 3:** Ease of use and interpretation of results.
- **Criterion 4:** Integration of advanced techniques (clustering , visualization, etc.).
- **Criterion 5:** Applicability in real contexts.

b. Neutrosophic Weights:

- **Criterion 1:** Weight [0.4; 0.5] (high importance).
- **Criterion 2:** Weight [0.3; 0.4] (medium-high importance).
- **Criterion 3:** Weight [0.2; 0.3] (medium importance).
- **Criterion 4:** Weight [0.1; 0.2] (low importance).
- **Criterion 5:** Weight [0.1; 0.2] (low importance).

c. Neutrosophic Scores:

- **Data Analysis Accuracy:** [0.85; 0.90] (high accuracy).
- **Ability to Manage Uncertainty:** [0.75; 0.80] (good ability).
- **Ease of Use and Interpretation of Results:** [0.90; 0.95] (very easy to use).
- **Integration of Advanced Techniques:** [0.80; 0.85] (good integration).
- **Applicability in Real Contexts:** [0.85; 0.90] (high applicability).

4. Validation of the Use of Orange Data Mining and Power BI

a. Robustness in the Face of Uncertainty:

- Orange Data Mining and Power BI demonstrate a good ability to handle uncertainty in data, especially when complemented by neutrosophic analysis. This reinforces their validity in contexts where data is imprecise or incomplete.

b. Consistency with the Study Objectives:

- The results obtained with Orange Data Mining and Power BI are consistent with the objectives of the study, as they allow patterns to be identified, data to be visualized and informed decisions to be made.

c. Comparison with Other Tools:

- Unlike other data analysis tools, Orange Data Mining and Power BI offer an intuitive graphical interface and a wide range of integrated techniques, making them easy to use in quantitative and descriptive research.

5. Discussion and Conclusions

a. Method Validation:

- Neutrosophic multicriteria analysis validates the use of Orange Data Mining and Power BI as primary methods in research, demonstrating their robustness, accuracy and applicability in handling complex data.

b. Contribution to the Field:

- The application of Orange Data Mining and Power BI in the context of scholarships is a significant contribution to the field, as it allows large volumes of data to be analyzed efficiently and effectively.

c. Recommendations for Future Research:

- Mining and Power BI are recommended for future research into complex social issues where data is often subject to inaccuracies and ambiguities.

Validating the use of Orange Data Mining and Power BI through a neutrosophic multi-criteria analysis demonstrates their robustness and applicability in contexts where data are uncertain and complex. These tools not only facilitate data analysis and visualization, but also enable informed and robust decisions to be made on complex social issues, such as the distribution of scholarships. Their use in future research could significantly improve the understanding and management of similar issues in other geographical or social contexts.

4. Discussion

The results show a significant effort on the part of the Ecuadorian educational system to Expand access to higher education through scholarships. The marked increase in the total number of scholarship recipients between 2020 and 2024, especially in technical and technological careers, suggests a policy aimed at meeting the needs of technical and highly specialized professionals (OECD, 2022). However, the fact that scholarships for technical and technological careers are much higher than those for postgraduate and undergraduate studies can indicate a need of revision for create a balance that allow he development of all educational levels (Tedesco , 2015).

The concentration of scholarship holders in the province of Guayas could be attributed to its high population density. Although there are already important educational institutions, it is important to consider the implications for equity in the distribution of opportunities between provinces (Bourdieu, 1986). The gender disparity found in the overall number of scholarship recipients, with a higher proportion of women, suggests that current scholarship policies are having a positive impact on gender equality (UN Women, 2020). However, this panorama must be studied in each region to ensure that equity is met in a homogeneous manner. The high prevalence of scholarship recipients with physical, visual and hearing disabilities is an indicator that the scholarship program is having a positive impact on inclusion (UNESCO, 2021). However, the lower proportions in other types of disability must be analyzed to identify barriers that may be limiting the access to these students. Finally, the overrepresentation of the ethnicity The fact that the mixed race among scholarship recipients indicates that an in-depth study is needed on the factors that could be limiting access to scholarships for other ethnic groups (De Sousa Santos, 2009).

5. Conclusions

This study provides a detailed overview of the distribution of scholarships in higher education in Ecuador in the period 2020-2024, evidencing both progress and inequalities in access to these benefits. The main findings show a significant increase in the total number of scholarship recipients, with special emphasis on the technical/technological level. Likewise, a concentration of scholarship recipients is observed in the province of Guayas, although with notable differences in terms of gender and ethnicity in various regions of the country. Another relevant aspect is the prevalence of scholarship recipients with physical, visual and hearing disabilities, as well as the predominance of scholarship recipients of mixed ethnicity. These results highlight the need for additional research to identify the underlying causes of these disparities. Only through in-depth analysis will it be possible to design strategies that promote a more equitable distribution of scholarships in terms of geography, ethnicity and inclusion of people with disabilities. In this context, the use of tools such as Orange and Power BI has proven to be effective in collecting, preprocessing, and analyzing data, facilitating the generation of knowledge for the formulation of more inclusive and equitable educational policies in Ecuador. From a neutrosophic perspective, this research can be enriched by incorporating neutrosophic logic in the analysis of the disparities found. Neutrosophic, as a theoretical framework developed by Florentin Smarandache, allows for the management of uncertainty, contradiction, and indeterminacy in the analysis of complex social phenomena. By applying neutrosophic methods, the factors that influence inequality in the distribution of scholarships can be modeled more accurately, considering not only dichotomous values (presence/absence of inequality), but also degrees of indeterminacy in the allocation of educational resources. In addition, techniques such as neutrosophic decision making and fuzzy neutrosophic sets could contribute to evaluating multiple criteria in the formulation of scholarship allocation policies. This would allow for a better identification of hidden patterns in the data, integrating diverse perspectives and avoiding biases in the interpretation of information. The application of these methods in future research could improve equity in the distribution of scholarships, ensuring effective inclusion of underrepresented groups in Ecuadorian higher education. In conclusion, the findings of this study constitute a fundamental basis for future research aimed at improving equity in higher education. The integration of advanced analysis tools and innovative approaches such as neutrosophy will contribute to the construction of fairer and more effective public policies in the educational field.

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