



Proposal for the use of the neutrosophic method of Shannon entropy

Leonso Dagoberto Torres Torres¹, Milena Elizabeth Alvarez Tapia², Paul Orlando Piray Rodríguez³,
Aymuxammedova Amina Kakajanovna⁴

¹Regional Autonomous University of Los Andes Santo Domingo, Ecuador

²Regional Autonomous University of Los Andes Tulcán, Ecuador

³Regional Autonomous University of Los Andes Riobamba, Ecuador

⁴Tashkent State University of Economics, Uzbekistan

Emails: us.leonsotorres@uniandes.edu.ec; ut.milenaalvarez@uniandes.edu.ec; ur.paulpr13@uniandes.edu.ec;
aminaaaymukammedova@gmail.com

Abstract

The authors suggest a new approach to create a composite index by fusing of information as well as applying Shannon Entropy but ready under one challenge that exists when it comes to understanding the complex nature of the exercising data and that is integrating information from different sources that are distinct and provide different facets of an estimation into one single best. In that sense, the modern world of information system is one which has to work with data which is in most cases erroneous and sometimes even contradictory, then the perspective of fusing at such information in a fruitful manner becomes very important. However, such information is not always available as it is only after the uncertainty of the relevant data has been difficult to make optimal use of decision making ability of a model. This paper goes some way to assisting with that issue and describes a framework that involves multiple information sources as well as how information entropy models the data uncertainty. The method put forward in the study employs the integration of information fusion with the application of Shannon entropy computation to come up with a composite index that best represents the particular system of interest in terms of its intricacy and the amount of uncertainty associated with it. Furthermore, the application of this composite index has practical implications in various areas, such as risk management, business decision-making and public policy evaluation, where precision in information integration is crucial to achieve effective results.

Keywords: Composite index; Information fusion; Shannon entropy; Uncertainty; Complex data analysis; Information integration; Decision making; Information systems; Risk management; Public policy evaluation

1. Introduction

The use of Composite Indices (CI) has emerged as a highly relevant strategy to address the numerical and simplified representation of complex phenomena. This approach involves the mathematical combination of individual indicators representing several dimensions into a single index, providing a comprehensive and structured view of the phenomenon in question [1]. A broad research effort in this field has been led by Greco et al. [2], who have compiled a wide range of publications addressing various techniques and applications related to the construction of composite indexes.

Despite the growing interest they have generated, composite indices remain the subject of debate and controversy both in academic and practical settings. Mazziotta & Pareto [3] highlight arguments in favor of the development of ICs, emphasizing their ability to condense complex or multidimensional problems into a single added value, which facilitates their interpretation compared to the evaluation of multiple independent indicators. Additionally, ICs allow focusing attention on the overall performance of the phenomenon under study, which is crucial for decision-making in the political sphere.

Indeed, the growing recognition of composite indices as a valuable tool is reflected in their adoption by numerous organizations both nationally and internationally. These indices are used for policy analysis, cross-entity comparison, performance monitoring, and public communication in a variety of fields, ranging from economics and the environment to technological development and society. [4]

The right to work is a fundamental pillar in a fair and equal society, and this right must be protected and guaranteed for all people, regardless of their gender, marital status or condition. However, pregnant women face additional challenges in the workplace, and the probationary period can become a particularly delicate stage for them [5] . During this time, situations of discrimination based on their pregnancy status can arise [6] , which violates their fundamental rights and perpetuates gender inequality in the workplace. [7]

In the Latin American context, various governments have joined forces to ensure, in an increasingly effective manner, the fulfillment of the rights of pregnant women in the workplace. In this regard, many countries in the region implement policies that guarantee a period of paid maternity leave for pregnant women. This measure, in some cases, is characterized by its extension and flexibility, allowing women to dedicate time to caring for themselves and their newborns without fear of losing their jobs. [8]

Similarly, laws have been enacted that prohibit the dismissal of pregnant women, the possibility of requesting adjustments in work schedules or conditions to ensure the well-being of the pregnant woman and her future children, among others. These laws provide additional protection during the period of maternity leave. These provisions contribute to ensuring the job stability of women during the period of pregnancy and the postpartum period. [9]

Other important approaches to this issue focus on the implementation of awareness-raising and training programmes aimed at employers and employees to address stereotypes and prejudices related to pregnancy in the workplace. This measure aims to create more inclusive and discrimination-free work environments. Additionally, some countries have taken specific measures to protect pregnant women from dangerous working conditions or risks to their health during pregnancy. Also noteworthy is the introduction of paternity leave into the legislation of several countries in the region, as it allows fathers to share family responsibilities and contributes to reducing gender discrimination in the workplace. [10]

However, certain forms of discrimination that pregnant women face in their workplace continue to persist on a recurring basis. In this regard, it has been observed that some companies, especially in the private sector, resort to terminating the contracts of pregnant women during the probationary period or after informing them of their pregnancy. Such actions constitute a clear form of employment discrimination, since, in most cases, a reason other than pregnancy is presented to justify the dismissal. [11]

Another common form of employment discrimination is a lack of employment opportunities. This can manifest itself in difficulties in finding employment due to prejudices or stereotypes associated with their pregnancy. Employers may have unfounded fears about the additional expenses or productivity of these women. Additionally, it is observed that, in some cases, there is a reduction in the responsibilities and tasks assigned to pregnant women. This can limit their professional progress and restrict their opportunities for development in the workplace.

In addition, lack of access to workplace benefits is another major concern. Pregnant women may be excluded from training opportunities, promotions, or bonuses due to their condition, which affects their career growth and compensation. In addition, some pregnant women face a hostile work environment where colleagues or superiors make inappropriate or derogatory comments about their pregnancy. This type of environment can lead to stress and negatively affect their job performance. [12]

These forms of labour discrimination against pregnant women represent a major challenge to gender equality and the protection of labour rights. In the Ecuadorian context, there are various regulations aimed at protecting the rights of pregnant women in the workplace.

First, the Constitution of Ecuador, in its article 23, enshrines the right to non-discrimination in the workplace, which includes protection against dismissal for reasons of pregnancy or maternity [13] . This constitutional provision strengthens the existing legal framework to safeguard the labor rights of pregnant women in the country [14] . On the other hand, the Labor Code of the Republic of Ecuador establishes a series of provisions aimed at protecting pregnant women in the workplace. Among these provisions is article 156, which expressly prohibits the dismissal of pregnant or breastfeeding women. Likewise, article 195 regulates ineffective dismissal when a pregnant woman is dismissed without just cause, further reinforcing the protection of her labor rights.

In addition, Ecuadorian female workers are entitled to 12 weeks of paid maternity leave, as established in Article 171 of the Labor Code. This leave can be enjoyed both before and after childbirth, which gives female workers flexibility to adapt it to their individual needs. Additionally, companies are required to have Internal Labor

Regulations that must include provisions related to the protection of the rights of pregnant and lactating women. These internal regulations constitute an additional instrument to ensure compliance with labor regulations regarding maternity protection.

Finally, it is important to note that Ecuador has ratified various international conventions related to women's labor rights, such as Convention 183 of the International Labor Organization (ILO) on Maternity Protection. This action reflects the country's commitment to international standards regarding the protection of workers' rights during pregnancy and maternity.

It is important to note that, despite the existence of these regulations, cases of discrimination and violation of the rights of pregnant women in the workplace persist. Lack of knowledge or non-compliance with these laws, as well as deep-rooted cultural attitudes, may be some of the factors that prevent the full protection of the labor rights of Ecuadorian women during pregnancy.

In this context, the present study aims to use the methodology of constructing a Composite Index to evaluate and analyze the level of protection of the labor rights of pregnant women in Ecuador. This research is based on the underlying model of the multidimensional concept of labor rights of pregnant women and seeks to identify areas of improvement in the country's labor policies and practices, in order to propose concrete recommendations that ensure greater protection and equity in the workplace for this vulnerable group of the population.

To carry out this study, the entropy method is used, a mathematical technique that measures the degree of uncertainty or disorder in a system. In the context of the construction of the composite index, entropy is used to weight the contribution of each indicator to the final composite index. This ensures that the indicators that provide more relevant and significant information for the protection of the labour rights of pregnant women have a greater weight in the construction of the index.

The application of the entropy method provides a solid and objective basis for the weighting of indicators, thus allowing for a more accurate and balanced assessment of the level of protection of pregnant women's labour rights. Furthermore, by considering the uncertainty inherent in each indicator, this approach helps mitigate biases and subjectivities in the construction of the composite index.

2. Materials and methods

Entropy method

The entropy method is based on the premise that the relative importance of a criterion should be determined by the amount of inherent information provided by the set of alternatives with respect to that criterion. Entropy, used in this method, is a measure of uncertainty in the information, which is calculated using probability theory. This theory states that a wide distribution of data reflects greater uncertainty than a distribution with more concentrated values. Therefore, the greater the diversity in the evaluations of the alternatives, the greater the importance of the criterion in the final decision, since it has a greater capacity to differentiate between the alternatives.

The method is based on measuring the diversity of a criterion through entropy. The calculated entropy is greater the more similar the evaluations of the alternatives are to each other. The application of this method involves considering a weighting that allows the subjective preferences of the decision-maker to be integrated with objective weightings derived from the intrinsic information of the data. When the evaluations of the alternatives with respect to a criterion are very similar, this criterion loses discriminatory power.

The entropy method provides a way to assess this loss of discrimination and determine the objective weighting of the criteria. It is important to note that this method does not allow the evaluation of criteria with values equal to or less than zero. [15]

The entropy method is calculated in the following steps:

Step 1. Constructing the decision matrix. Suppose a set of m components, capturing different aspects of performance, are arranged in the following matrix format:

$$\begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix}$$

Step 2. The objective of calculating the normalized decision matrix P_{ij} is to obtain dimensionless values of several criteria in order to compare them with each other. This calculation is performed using equation (1).

$$P_{ij} = \frac{x_{ij}}{\sum_{i=1}^m x_{ij}} \quad (1)$$

Step 3. Calculation of entropy E_j , using equation (2)

$$E_j = -k \left(\sum_{i=1}^m P_{ij} \ln(p_{ij}) \right), \text{ where } t = 1, 2, 3, \dots, n. \quad (2)$$

Where $k = \frac{1}{\ln m}$ is a constant that guarantees $0 \leq E_j \leq 1$ and m is the number of alternatives.

Step 4. Calculation of the diversity of criteria D_j , equation (3) allows to calculate this parameter.

$$D_j = 1 - E_j \quad (3)$$

Step 5. Calculation of the normalized weight W_j of each criterion, using Equation (4).

$$W_j = \frac{D_j}{\sum_{i=1}^m D_j} \quad (4)$$

Entropy assigns a higher weight to component indicators that present a higher variability, since these indicators offer a higher discriminatory capacity and are therefore more relevant in the decision-making process. In contrast, component indicators with a relatively lower variation receive a lower weight due to their lower importance in the decision-making process. In this sense, and using the weights obtained in the previous step, the composite indicator can be calculated using Equation (5).

$$I_{comp} = \sum_{j=1}^n W_j \check{I}_j \quad (5)$$

where W_j represents the weight obtained through Shannon entropy for indicator j \check{I}_j and is the normalized value of indicator j .

Among the main advantages of entropy in the construction of composite indicators is, first, that it produces a set of common weights that allow for an exhaustive comparison and classification of all decision units. Second, its implementation is simple. Compared to the equal weighting approach, which assigns the same weight to all component indicators, the proposed weighting scheme provides a higher discriminatory capacity [16, 17, 18].

3. Results

Taking into account the purpose of the research, a careful selection of indicators that meet the specific needs of the composite indicator to be developed is suggested. After a rigorous process of selection and discrimination between various elements, six indicators were identified that, according to the evaluation of experts, offer the best performance for obtaining the composite indicator that aims to measure the level of protection of the labor rights of pregnant women in Ecuador. The selected indicators are presented in Table 1.

Table 1: Indicators to measure the level of protection of pregnant workers in Ecuador.

Code	Indicator	Scope
CI1	Access to paid maternity leave	Evaluates the availability and access of pregnant women to paid maternity leave in accordance with Ecuadorian labor legislation.
CI2	Protection against discriminatory dismissal	Examines legal provisions and business practices that protect pregnant women from unfair and discriminatory dismissal.

CI3	Equal pay during pregnancy	Analyzes the existence of labor policies and practices that guarantee equal pay between pregnant and non-pregnant women in the same job.
CI4	Access to support programs and work flexibility	Assess the availability of programs and measures that provide support and flexibility to pregnant women in the workplace.
CI5	Awareness and training on labour rights	Measures the implementation of awareness-raising and training programs aimed at employers and workers on women's labor rights.
CI6	Existence of effective reporting and protection mechanisms	Examines the existence and effectiveness of reporting and protection mechanisms for pregnant women facing discrimination in the workplace.

The indicator selection process is crucial to ensure the validity and reliability of the final composite indicator. The criteria for selecting these indicators were based on their ability to capture different relevant aspects of pregnant women's labor rights in the Ecuadorian context, as well as their potential to provide meaningful and representative information in the composite analysis. The selected indicators are considered essential to properly understand and assess the situation of pregnant women in the Ecuadorian workplace and to inform potential areas of improvement in labor policies and practices in the country.

Once the indicators have been selected for incorporation into the composite indicator, they are evaluated by means of the participation of a panel made up of six experts. This evaluation process is based on considering the level of information known and its contribution to the global indicator that is intended to be developed. The panel of experts is carefully selected, taking into account their experience and knowledge in the area of labor rights in Ecuador. The aim is to have a variety of perspectives and skills that allow for a comprehensive and objective evaluation of the selected indicators.

During the assessment, experts examine each indicator in depth, considering its relevance, reliability, sensitivity, feasibility and objectivity, according to previously established criteria. The degree to which each indicator accurately and comprehensively reflects the protection of pregnant women's labour rights in the Ecuadorian context is analysed. The experts use their experience and knowledge to assess the coherence and consistency of the indicators, as well as their ability to provide relevant and useful information for decision-making. The contribution of each indicator to the overall composite indicator is also considered, ensuring that all relevant aspects are adequately represented and weighted.

From this analysis, a matrix is generated that contains the assessments that each of the experts has given to the selected indicators. Each expert assigns a score from 1 to 5 to each alternative, reflecting the degree of compliance with the criteria established for the evaluation of the indicators. The results of this evaluation are presented in an organized manner in Table 2. This evaluation matrix allows us to know in detail the perceptions and assessments of the experts regarding each indicator, allowing us to identify possible discrepancies in opinions and areas of consensus. In addition, it facilitates the identification of strengths and weaknesses of each indicator in terms of its relevance, reliability, sensitivity, practicality and objectivity.

Table 1: Evaluation matrix.

Experts	IC1	IC2	IC3	IC4	IC5	IC6
E1	3	4	4	3	4	3
E2	4	5	3	4	3	4

E3	3	5	3	4	4	5
E4	4	3	2	4	3	4
E5	2	5	3	4	5	4
E6	5	4	5	4	4	5

These data allow the calculation of entropy and the determination of corresponding weights for each selected indicator. The process of calculating entropy and weights is based on the information gathered through the assessment carried out by the expert panel. Entropy is calculated for each indicator, reflecting the diversity of assessments provided by experts regarding that specific indicator. The higher the entropy, the greater the variability in experts' perceptions of the indicator, suggesting a higher importance of that indicator in the dataset. The results obtained from this analysis are presented in detail in Table 3.

Table 2 Calculation of E_j , D_j , and W_j according to the entropy method.

Indicators	Entropy E_j	D_j	W_j
CI1	0.887	0.113	0.174
CI2	0.914	0.086	0.132
CI3	0.882	0.118	0.181
CI4	0.878	0.122	0.187
CI5	0.904	0.096	0.147
CI6	0.883	0.117	0.180

With the availability of these data, it is possible to obtain and calculate the composite indicator following the methodology established in equation (5).

$$I_{comp} = (0.174 * I_1) + (0.132 * I_2) + (0.181 * I_3) + (0.187 * I_4) + (0.096 * I_5) + (0.180 * I_6)$$

The formulation of the composite indicator involves combining different aspects assessed around the labour rights of pregnant women in the Ecuadorian context, represented by the selected indicators. The appropriate weighting of these indicators ensures that they are reflected in a balanced and representative manner in the final composite indicator, thus providing a comprehensive measure of the level of protection of these rights.

4. Discussion

The study carried out made it possible to identify the different elements that contribute to the protection of the labor rights of pregnant women in Ecuador. The research focused on the careful selection of indicators, their evaluation by experts and the subsequent construction of a composite indicator capable of measuring this element from different perspectives. As mentioned in various related studies, various forms of discrimination against pregnant women in the Ecuadorian workplace were found, including unjustified dismissals, denial of promotions, reduction of working hours, and inappropriate reassignment of tasks.

Furthermore, the creation of a composite indicator that allows determining and analyzing the level of protection of the labor rights of pregnant women in Ecuador is of fundamental importance in the socioeconomic and legal context of the country. This tool offers a comprehensive and systematic view of the employment situation of pregnant women, allowing the identification of areas for improvement and the design of policies aimed at ensuring

equal opportunities and the effective protection of their rights. The construction of this indicator allows the integration of multiple dimensions and relevant aspects of the labor rights of this population into a single index, facilitating interpretation and informed decision-making by policy makers and employers. This synthesis of information contributes to a more holistic understanding of the employment situation of pregnant women, avoiding data fragmentation and providing a more complete view of the labor reality.

According to [16], the creation of these indicators allows for national and international comparisons, facilitating the identification of best practices and areas for improvement. By contrasting the results obtained with similar research carried out in other countries or regions, common trends, patterns and challenges can be identified that require attention and action by the competent authorities.

Furthermore, the use of the entropy method during the process allowed to assess the diversity and variability of the evaluations provided by the expert panel regarding each indicator selected for the composite indicator. In this way, the indicators that generate more divergent opinions among the experts could be identified, suggesting that these indicators are more relevant and have a greater impact on the data set. Additionally, the use of this method facilitated the identification of the intrinsic information provided by each indicator, allowing to assign objective weights to the indicators based on their ability to discriminate between the different perceptions of the experts. According to [17], indicators with lower entropy are considered more informative and therefore receive higher weights in the calculation of the composite indicator, thus reflecting their importance in the overall evaluation.

The analysis conducted during this study has significant implications for legal sciences and Ecuadorian society as a whole. From a legal perspective, the results obtained provide a solid basis for assessing the effectiveness of existing labor laws and regulations in Ecuador in protecting labor rights. By identifying areas for improvement and potential deficiencies in current legislation, the findings of this research can inform the development of policies and legal reforms aimed at strengthening the protection of this vulnerable group in the labor market [18,19].

In the context of Ecuadorian society at large, the results of this study may have an impact on promoting gender equality and protecting human rights in the workplace. By highlighting potential discriminatory practices and the specific challenges faced by pregnant women in the labor market, this research may contribute to raising awareness in society about the importance of ensuring fair and equitable working conditions for all workers, regardless of their pregnancy status. Furthermore, by providing empirical evidence on the situation of pregnant women in the workplace, this study may support the efforts of human rights defenders and civil society organizations advocating for concrete policies and measures to protect and promote the labor rights of this vulnerable group [20].

5. Conclusion

This study has made it possible to make significant progress in understanding and assessing the level of protection of the labor rights of pregnant women in Ecuador through the creation of a composite indicator that involves various indicators of interest. In this sense, the selection of these indicators was crucial to ensure the representativeness and relevance of the composite indicator. The application of the Shannon entropy method to determine the weights of the indicators provides an objective measure of the relative importance of each indicator in the data set. This methodology allows for an adequate weighting of the different aspects assessed, ensuring a balanced representation in the final composite indicator.

The calculation of the composite indicator, which combines the different aspects assessed in relation to the labor rights of pregnant women in Ecuador, has made it possible to obtain a comprehensive and representative measure of the level of protection of these rights. This composite indicator can be a valuable tool for policy formulation, decision-making and the promotion of inclusive and equitable work environments for all workers, regardless of their pregnancy status.

Funding: “This research did not receive external funding”

Conflicts of interest: “The authors declare that they have no conflict of interest.”

References

- [1]. J. Lan, S. Ullah, M. Sadiq, F. Chien, and Z. A. Baloch, “Assessing energy poverty and its impacts using a DEA-like multidimensional mathematical composite indicator approach: Findings from Asia,” *Energy Policy*, vol. 165, p. 112933, 2022..
- [2]. S. Greco, A. Ishizaka, M. Tasiou, and G. Torrisi, “The ordinal input approach to cardinal output of noncompensatory composite indicators: The PROMETHEE scoring method,” *Eur. J. Oper. Res.*, vol. 288, no. 1, pp. 225–246, 2021, [Online]. Available at: <https://www.sciencedirect.com/science/article/abs/pii/S037722172>..
- [3]. M.Z. Hosen, M. Habibullah, and M. Hajizadeh, “Effects of maternal employment on child undernutrition in South Asia: an instrumental variable approach,” *Nutrition*, vol. 105, p. 111851, 2023.
- [4]. D.-A. Davis, “Reproducing while black: The crisis of black maternal health, obstetric racism, and assisted

- reproductive technology,” *Reprod. Biomed. Soc. Online* , vol. 11, pp. 56–64, 2020, .
- [5]. MC Lo, T. T. N. Le, M. Santos, and K. Sen, “Gender and vulnerable employment in the developing world: evidence from global microdata,” *World Dev.* , vol. 159, p. 106010, 2022.
- [6]. I. Berniell, L. Berniell, D. de la Mata, M. Edo and M. Marchionni, “Motherhood and flexible jobs: evidence from Latin American countries”, *World Dev.* , vol. 167, p. 106225, 2023.
- [7]. Gandhi, C. P., Xiang, J., Kumar, A., Vashishtha, G., & Kant, R. (2022). Maximal overlap discrete wavelet packet transforms-based bipolar neutrosophic cross entropy measure for identification of rotor defects. *Measurement*, 200, 111577
- [8]. Gandhi, C. P., Kumar, A., Vashist, G., Tang, H., Rai, A., & Xiang, J. (2022). Maximal overlap discrete wavelet packet transforms and variants of neutrosophic cubic cross-entropy-based identification of rotor defects. *Measurement Science and Technology*, 33(8), 085107
- [9]. JL Maldonado, S. Montecé, JR Cabrera, and SA Gallo, “Rights And Inclusion Of Pregnant And Breastfeeding Women In Ecuadorian Universities,” *J. Posit. Sch. Psychol.* , pp. 8596–8610, 2022,.
- [10]. Duong, T. T. T., Thao, N. X., & Smarandache, F. (2021). New Entropy, Similarity Measures of Interval-Valued Neutrosophic Sets, and Application in Supplier Selection. *Neutrosophic Operational Research: Methods and Applications*, 35-54
- [11]. Ecuador National Constituent Assembly, “Constitution of the Republic of Ecuador.” Official Register 449. Last modified: Jan. 25, 2021. Government of Ecuador, Quito, Ecuador, 2008.
- [12]. L.T. Reynolds, “Gender equity, labour rights and women’s empowerment: lessons from Fairtrade certification on Ecuadorian flower plantations”, *Agric. Human Values* , vol. 38, no. 3, pp. 657–675, 2021.
- [13]. A. Sarra, E. Nissi, A. Evangelista, and T. Di Battista, “A functional approach to construct dynamic composite indicators,” *Stat. Methods Appt.* , pp. 1–32, 2023.
- [14]. Dwivedi, P. P., & Sharma, D. K. (2022). Application of Shannon entropy and CoCoSo methods in selection of the most appropriate engineering sustainability components. *Cleaner Materials*, 5, 100118.
- [15]. Singh, P. (2020). A neutrosophic-entropy based clustering algorithm (NEBCA) with HSV color system: A special application in segmentation of Parkinson’s disease (PD) MR images. *Computer methods and programs in biomedicine*, 189, 105317
- [16]. Şahin, R. (2017). Cross-entropy measure on interval neutrosophic sets and its applications in multicriteria decision making. *Neural Computing and Applications*, 28, 1177-1187
- [17]. Sherwani, R. A. K., Arshad, T., Albassam, M., Aslam, M., & Abbas, S. (2021). Neutrosophic entropy measures for the Weibull distribution: theory and applications. *Complex & Intelligent Systems*, 7(6), 3067-3076.
- [18]. L. Abdullah, "A Normalized Weighted Bonferroni Mean Aggregation Operator Considering Shapley Fuzzy Measure Under Interval-Valued Neutrosophic Environment for Decision-Making," *International Journal of Fuzzy Systems*, vol. 22, no. 4, pp. 1177–1191, Apr. 2020.
- [19]. Wu, Y., Zhou, Y., Saveriades, G., Agaian, S., Noonan, J. P., & Natarajan, P. (2013). Local Shannon entropy measure with statistical tests for image randomness. *Information Sciences*, 222, 323-342.
- [20] N. X. Thao, "Apply New Entropy-Based Similarity Measures of Single Valued Neutrosophic Sets to Select Supplier Material," *Journal of Intelligent & Fuzzy Systems*, vol. 39, no. 1, pp. 1005–1019, 2020