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Neutrosophic Multicriteria Method for Evaluating the Impact of Informal Trade on the "Mariscal de Puyo" Market

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Abstract. When people from different backgrounds offer products and services to the general public without complying with the legal parameters that a business requires, they generate a phenomenon known as the Informal Trade. In the "Mariscal de Puyo" market, there has been a flourishing of the informal trade for the commercialization of basic needs, which is gaining space in the internal supply chain of Ecuador. Quantifying its impact on society represents a task little tackled by science. This research proposes a solution to the posed problem by developing a method to evaluate the impact of informal trade. The proposed method bases its operation on a neutrosophic multi-criteria approach. A case study is implemented with the purpose of measuring the impact of informal trade on the "Mariscal de Puyo" market.

Keywords: Multi-criteria decision-making, single-valued neutrosophic set, informal trade.

1. Introduction

The progress of the mercantile society is directly related to the levels of commerce with which economic transactions are carried out [1]. Economic transactions can be managed through a formal or informal market. The informal market has increased and expanded its forms of management in the diverse regions of Ecuador [2, 3].

After the expansion of informal markets, the community changes the perspective on this type of commercial form [4, 5]. Informal trade is characterized by the following aspects [6, 7]:

- Informal management of sales or services.
- A considerable movement of cash and non-commercial bank transactions.
- Evidence of a relationship with poverty, lack of production in the region.
- The development of creativity due to the need to find a profitable way to work.

Informal trade represents the performance of economic or service activities that are kept fundamentally hidden from The State administration, which brings along a set of legal consequences and support for society since people do not have guarantees on the products obtained in such market, although it is obvious that the level of accessibility reaches a greater number of people [8, 9].

Based on the situation described above, this research aims to develop a method for evaluating the impact of informal trade. The proposed method consist of a multi-criteria approach based on evaluative criteria for evaluation.

The international movement known as Paradoxism based on contradictions in science and literature, was founded by Florentin Smarandache, who then extended it to Neutrosophy, which is a science that studies contradictions and their neutrals [10]. To model with single-valued neutrosophic sets makes it possible to make decisions considering indeterminate terms. This is a way to evaluate more reliable than using fuzzy sets, because experts' knowledge is usually full of unclear information, contradiction or inconsistency.

The present paper is divided in the following sections: Section of Materials and Methods contains the basic concepts and the design of the proposed method. Section of Results is dedicated to apply the proposed model to the actual situation of informal trade in the "Mariscal de Puyo" market. We end the paper with the conclusions.

2. Materials and Methods

This section describes the operation of the proposed method to assess the impact of informal trade. We also present the general characteristics of the proposed solution. The main stages and activities that make up the method are described below.

The method for the evaluation of the impact of informal trade is designed under a group of qualities [11]. The qualities that distinguish the method are:

- Integration: the method guarantees the interconnection of the different components as a whole for the evaluation of the impact of informal trade.
- Flexibility: uses 2-tuples to represent uncertainty so as to increase the interoperability of the experts who interact with the method.
- Interdependence: the method uses the input data provided by the experts as a starting point. The analyzed results contribute to a base of experience that forms the core of the inference process.

The method is based on the principles:

- Identification through the team of experts of the indicators to evaluate the impact of informal trade.
- Definition and processing under a multi-criteria approach.
- The use of multi-criteria methods in the evaluation.

The method to assess the impact of informal trade, is structured to manage the workflow of the evaluation process based on a multi-criteria inference method. It has three fundamental stages: input, processing and output of information [12]. Figure 1 shows a diagram illustrating the general operation of the method.

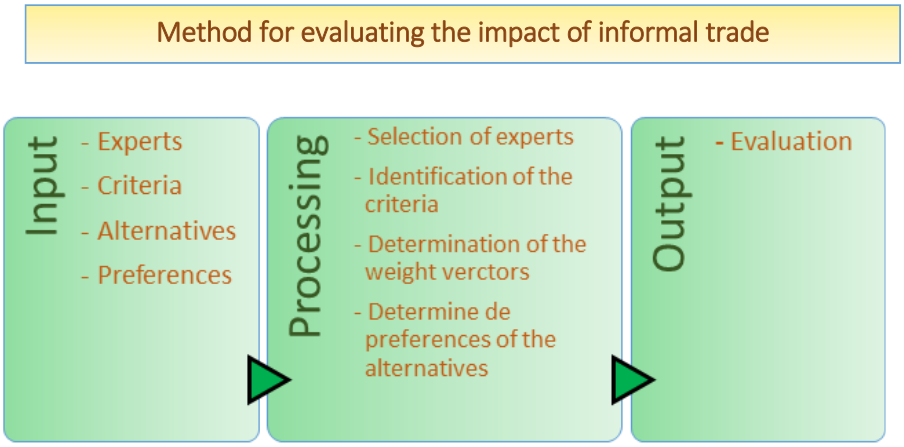

Figure 1. General scheme of the method.

2.1 Description of the stages

The proposed method is designed to ensure workflow management for the informal trade impact assessment process. It uses a multi-expert multi-criteria approach where evaluative indicators are identified to determine the operation of the method.

The processing stage is structured in four activities that control the inference process. Figure 2 shows a diagram with the activities of the processing stage.

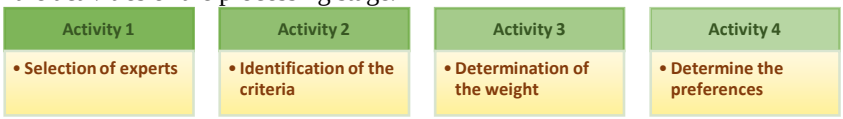

Figure 2. Processing stage activities.

Activity 1 Selection of experts:

The process consists of determining the group of experts involved in the process. For the selection, we used the methodology proposed by Fernández [13]. To start the process, a model is sent to potential experts with a brief

explanation of the objectives of the work and the area of knowledge in which the research is focused. Then the following activities are carried out:

Experts are contacted and asked to participate in the panel. The activity results in the recruitment of the group of experts who will participate in the application of the method.

The process should filter out the experts having a low level of expertise, rather choosing those with more knowledge and prestige in the subject of the research. To execute the filtering process, experts carry out a self-evaluation questionnaire. The objective is to determine the knowledge or information coefficient (K_c) they have. Equation 1 expresses the method to determine the level of expertise

$$K_c \in (0,1) \tag{1}$$

Where:

K_c: Knowledge or information coefficient,

Activity 2 Identification of the criteria:

Once the experts involved in the process and the evaluation criteria have been identified, we move on to the next step. The criteria represent the input parameters used in the processing stage. From the experts work group, the following activities are carried out:

A questionnaire is sent to the panel members and they are asked for their opinion of the selection of the evaluation criteria supporting the research. From a previously prepared questionnaire, the set of experts' criteria is obtained.

Responses are analyzed and the areas in which they agree and disagree are identified. This activity let us analyze the behavior of the answers issued by the experts and identify the common elements.

The summary analysis of all the responses is sent to the members of the panel, and they are asked to fill out the questionnaire again and give explanations on the opinions they differ. This allows obtaining a new assessment from the group of experts on the knowledge collected and summarized.

The process is repeated until the responses stabilize. The activity represents the method's stop condition, from which the responses are stabilized. Once the condition is reached, its application is concluded, considering this the general result.

The activity results in the set of evaluative criteria of the method. A multi-criteria approach expressed as $C = \{c_1, c_2, , , c_m\}$ as a set of criteria, where $m > 1$.

Activity 3 Determination of the weight vectors of the criteria:

The experts group involved in the process determine the weights attributed to the evaluation criteria. They are asked to assess the importance level attributed to the evaluation criteria identified in the previous activity.

The weights of the evaluation criteria are expressed by a domain of *single-valued neutrosophic numbers*.

This is defined by the following expressions:

Definition 1: ([14]) Let X be a universe of discourse. A *Neutrosophic Set* (NS) is characterized by three membership functions, $u_A(x), r_A(x), v_A(x) : X \rightarrow \,]^-0, 1^+[$, which satisfy the condition $^-0 \leq \inf u_A(x) + \inf r_A(x) + \inf v_A(x) \leq \sup u_A(x) + \sup r_A(x) + \sup v_A(x) \leq 3^+$ for all $x \in X$. $u_A(x), r_A(x)$ and $v_A(x)$ denote the membership functions of truthfulness, indetermination and falseness of x in A, respectively, and their images are standard or non-standard subsets of $]^-0, 1^+[$.

NS are useful only as a philosophical approach, so *Single-Valued Neutrosophic Set* is defined to guarantee the applicability of Neutrosophy, see Definition 2.

Definition 2: ([14]) Let X be a universe of discourse. A *Single-Valued Neutrosophic Set* (SVNS) A on X is an object of the form:

$$A = \{\langle x, u_A(x), r_A(x), v_A(x)\rangle : x \in X\} \tag{1}$$

Where $u_A, r_A, v_A : X \rightarrow [0,1]$, satisfy the condition $0 \leq u_A(x) + r_A(x) + v_A(x) \leq 3$ for all $x \in X$. $u_A(x), r_A(x)$ and $v_A(x)$ denote the membership functions of truthfulness, indetermination and falseness of x in A, respectively. For convenience a *Single-Valued Neutrosophic Number* (SVNN) will be expressed as $A = (a, b, c)$, where $a, b, c \in [0,1]$ and satisfies $0 \leq a + b + c \leq 3$.

Neutrosophic Logic (NL) extends fuzzy logic. As stated by Florentin Smarandache a proposition P is characterized by three components; see[15]:

$$NL(P) = (T, I, F) \tag{2}$$

Where component T is the degree of truthfulness, F is the degree of falsehood and I is the degree of indetermination. T, I, and F belong to the interval [0, 1], and they are independent from each other.

Linguistic terms are used to increase interpretability when determining the weight vectors associated to the criteria [16, 17]. Table 1 shows the set of linguistic terms with their respective values.

Linguistic term	Value
No important	(0.10,0.90,0.90)
Less important	(0.20,0.85,0.80)
Slightly important	(0.30,0.75,0.70)
Somewhat important	(0.40,0.65,0.60)
Average importance	(0.50,0.50,0.50)
Important	(0.60,0.35,0.40)
Very important	(0.70,0.25,0.30)
Strongly important	(0.8,0,15,0.20)
Very strongly important	(0.9, 0.1, 0.1)
Extremely important	(1,0,0)

Table 1. Domain of values to assign weight to the criteria.

Once the weight vectors of each expert involved in the process have been obtained, an information aggregation process is carried out using an average function as shown in Equation 3.

$$w_j = \frac{\sum_{i=1}^{n} x_{ij}}{n} \tag{3}$$

Where:
w_j: is the aggregated value, that is to say, the weight of the j-th criteria.
n : is the number of experts involved in the process,
x_{ij}: is the evaluation expressed by expert i on the criteria C_j.
To obtain a crisp value from a single-valued neutrosophic number the following formula can be applied:

$$\boldsymbol{S}(\mathrm{T},\mathrm{I},\mathrm{F}) = \frac{1}{3}(2 + \mathrm{T} - \mathrm{I} - \mathrm{F}) \tag{4}$$

Activity 4 Determine the preferences of the alternatives:

The activity to determine preferences consists of identifying the impact that the evaluation criteria have on the studied phenomenon.

For the evaluation of the impact of informal trade, the problem and the evaluation of each alternative from which the evaluation matrix is formed are described [18-20]. The matrix is made up of the alternatives, the criteria and the evaluation of each criterion for each alternative. Figure 3 shows the output of the proposed decision-making problem.

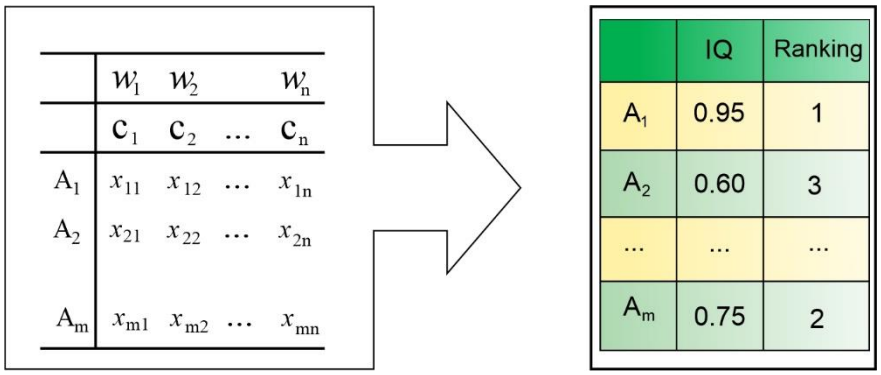

Figure 3. Proposed decision making problem.

After obtaining the preferences of each evaluative criterion about the object of study, we carry out the information inference process. Inference is guided by the use of information aggregation operators.

Le $A = \{A_1,A_2,...,A_m\}$ be the set of alternatives, and $E = \{E_1,E_2,...,E_n\}$ be the set of experts. Each expert assesses each alternative by each criterion. Thus x_{ijk} means the evaluation expressed by expert i on the criteria C_j on alternative A_k. The scale of evaluation is given in Table 2.

Linguistic expressions	Single-valued neutrosophic number (T, I, F)
Very bad (VB)	(0.10, 0.75, 0.85)
Bad (B)	(0.25, 0.60, 0.80)
Medium bad (MB)	(0.40, 0.70, 0.50)
Medium (M)	(0.50, 0.40, 0.60)
Medium Good (MG)	(0.65, 0.30, 0.45)
Good (G)	(0.80, 0.10, 0.30)
Very Good (VG)	(0.95, 0.05, 0.05)

Table 2: Linguistic terms and their single-valued neutrosophic numbers for evaluating alternatives according to the criteria.

The aggregation process is carried out with the use of information aggregation operators [21-23]. The fundamental objective is to obtain collective assessments from individual evaluations through the use of aggregation operators. The OWA (Ordered Weighted Averaging) aggregation operator is used to process the proposed method [24-26].

The OWA operators work similar to the weighted average operators, although the values that the variables take are previously sorted in descending order and, opposed to what happens in the weighted averages, the weights are not associated with any specific variable [27-29].

Then, b_j is the value of the evaluation of alternative k-th according to the j-th criteria for all experts.

$$b_{jk} = \frac{\sum_{i=1}^{n} x_{ijk}}{n} \tag{5}$$

The result per alternative is calculated as follows:

$$R_k = \frac{\sum_{j=1}^{n} w_j \wedge b_j}{6} \tag{6}$$

Where, $w_j \wedge b_j := \left(min\left(T_{w_j} \wedge T_{b_j}\right), max\left(I_{w_j} \wedge I_{b_j}\right), max\left(F_{w_j} \wedge F_{b_j}\right)\right)$.

Finally, the alternatives are sorted in descending order according to A_{k_1} is preferred over A_{k_2} if and only if $\boldsymbol{S}(R_{k_1}) > \boldsymbol{S}(R_{k_2})$, using Equation 4.

3. Results

For the implementation of the method, a case study has been developed where we represent an instrument focused on the specific case that is modeled. The object of analysis was the "Mariscal de Puyo" market in Ecuador, which is the only alternative to be considered. The objective was to evaluate the impact of informal trade on this market.

Below are the ratings achieved for each activity:

Activity 1 Selection of experts:

To apply the method, we applied a questionnaire in order to select the group of experts to participate in the process. Eight experts were selected for the panel. The self-assessment questionnaire was applied to the 8 experts. Specifically, four questions were applied to the experts. The following results were obtained to identify the degree of knowledge on the subject:

Question 1. Theoretical analyzes carried out by you on the subject:

Five experts granted themselves the evaluation of "High" and the other 3 experts thought their knowledge is "Average".

Question 2. Study of works published by Ecuadorian authors:

We obtained a self-evaluation of High for 5 experts, Average for 2 experts and Low for 1 expert.

Question 3. Direct contact with the informal market:

A self-assessment of High was obtained for 5 experts, Medium for 2 experts and Low for 1 expert.

Question 4. Knowledge of the current state of informal trade:

Six experts got themselves a self-assessment of High, Medium for 1 experts and Low for 1 expert.

After aggregating these results we obtain the following conclusions about expertise:

- 5 experts self-evaluate with a level of competence on the subject under study of 10 points.
- 1 expert self-assess with a competence level of 9 points.
- 1 expert self-evaluates with a proficiency level of 8 points.
- 1 experts self-evaluate with a level of competence of 6 points.

The knowledge coefficient K_c represents an important parameter in the application of the proposed method. For the investigation, the K_c per expert are obtained as reported in Table 3, where the values are divided by 10:

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
10	9	1	6	8	1	1	1

Table3. Knowledge coefficient by experts.

Figure 4 shows a graph with the behavior of the experts' knowledge coefficients. From the analysis of the results, we determined to select 7 of the 8 experts originally planned.

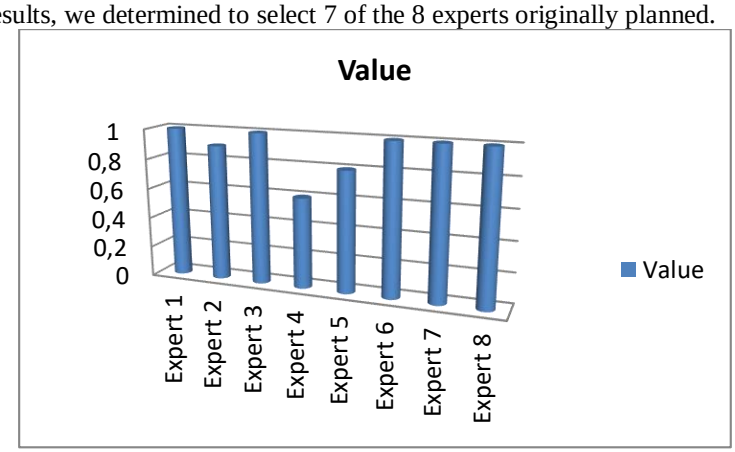

Figure 4. Representation of the knowledge coefficient of the experts.

Activity 2 Identification of the criteria:

For the activity, the experts involved in the process were surveyed. The objective was to identify the assessment criteria to evaluate informal trade. The indicators constitute the fundamental element on which the processing is carried out in subsequent stages.

Table 4 displays the evaluation criteria obtained from the activity.

Number	**Evaluation criteria**
C_1	Product quality certificate
C_2	Competitive prices
C_3	Contribution to the employment of personnel
C_4	Variety of products
C_5	Accessibility
C_6	Hygienic and sanitary conditions

Table 4. Evaluative criteria obtained.

Activity 3 Determination of the weight vectors of the criteria:

To determine the weights on the criteria, we used a multi-expert approach, in which the 7 selected experts intervened. Using single-valued neutrosophic numbers as proposed in Table 1, the group of experts did their job.

From the aggregation carried out using Equation 4, the weights of the 7 experts are combined into a unique value. Table 5 shows the result of the weight vectors as a result from the activity.

Number	Weight vectors W for criteria C
C_1	(0.1630, 0.35,0.40)
C_2	(0.9, 0.1,0.1)
C_3	(0.1521, 0.50,0.50)
C_4	(0.1847, 0.15,0.20)
C_5	(0.1304, 0.75,0.70)
C_6	(0.1739, 0.25,0.30)

Table 5: Weights of the criteria based on experts' opinions.

Activity 4 Determine the preferences of the alternatives:

In order to evaluate the impact of informal trade on the "Mariscal de Puyo" market in Ecuador, an evaluation of compliance with the criteria was carried out. The weight vectors attributed to each evaluation criterion were used as starting information. Compliance with the indicators in the "Mariscal de Puyo" market was evaluated using the set of linguistic labels proposed in Figure 3.

As a result, we obtained a system with fuzzy values that are added as output values. Table 6 shows the result of the process.

Criteria	W	Aggregated Evaluation b_j	$w_j \wedge b_j$
C_1	(0.1630, 0.35,0.40)	(0.67, 0.35,0.40)	(0.1630, 0.35,0.40)
C_2	(0.9, 0.1,0.1)	(0.83, 0.15,0.20)	(0.83, 0.15,0.20)
C_3	(0.1521, 0.50,0.50)	(1, 0,0)	(0.1521, 0.50,0.50)
C_4	(0.1847, 0.15,0.20)	(0.67, 0.35,0.40)	(0.1847, 0.35, 0.40)
C_5	(0.1304, 0.75,0.70)	(0.83, 0,15,0.20)	(0.1304, 0.75,0.70)
C_6	(0.1739, 0.25,0.30)	(0.5, 0.50,0.50)	(0.1739, 0.50,0.50)
Index $\frac{\sum_{j=1}^{6} w_j \wedge b_j}{6}$			(0.27235, 0.43333, 0.45000)

Table 6. Result of evaluations obtained by experts.

The final value of the score degree is 0.46301.

Figure 5 shows the behavior of inferences on the evaluation criteria for the proposed case study.

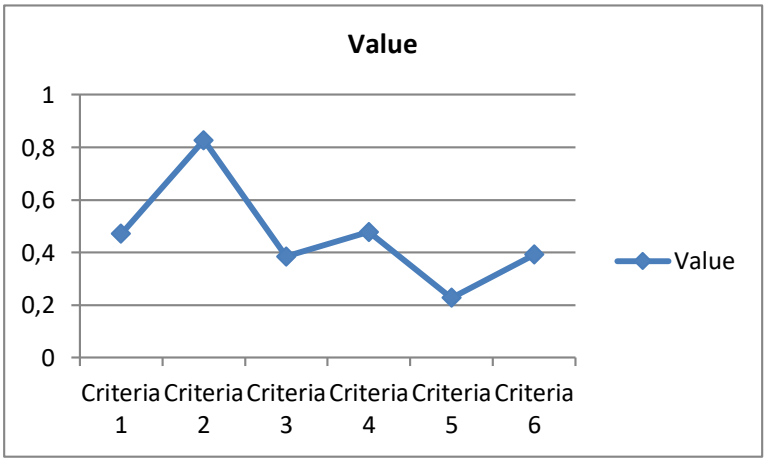

Figure 5. Alternative evaluation per criteria.

From the data presented in Table 6, an impact index of informal trade for the "Mariscal de Puyo" market in Ecuador with a value of 0.46301 is identified. The results are classified as a medium index of impact of informal trade. We made the classification of 0.46301 according to a linguistic value, using the scale shown in Figure 6, such that the maximum truth-value of 0.46301 is obtained when evaluating in the membership function corresponding with the label "medium".

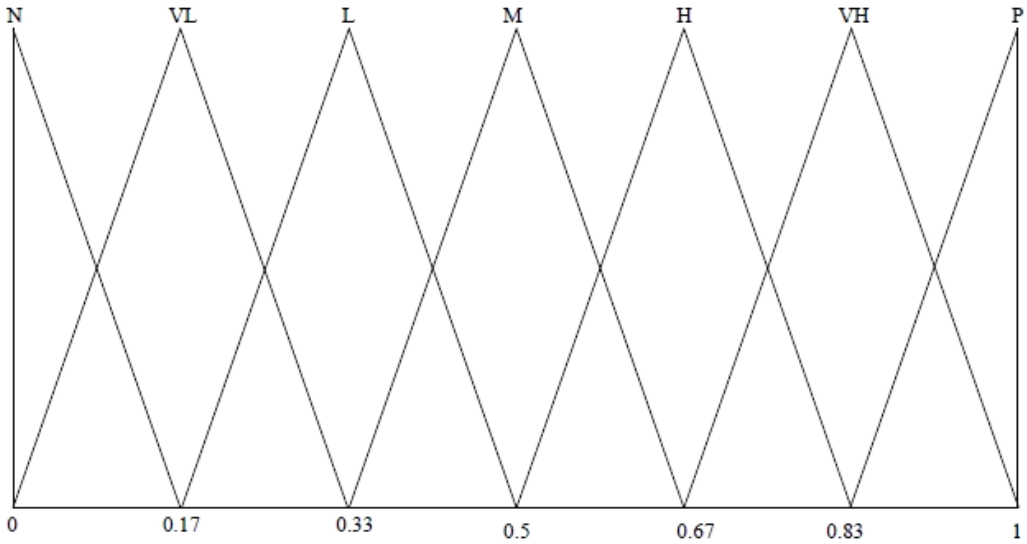

Figure 6. Linguistic labels set.

Where:
N: Null,
VL: Very Low,
L: Low,
M: Medium,
H: High,
VH: Very High,
P: Preferred.

Conclusions

From the implementation of the proposed method, weights of aggregation are obtained for the assessment of the criteria that represented the basis of the evaluation process for the informal market.

Eight potential experts were analyzed, 7 of which were selected based on their competence coefficient for the implementation of the proposed method.

The application of a case study to assess the impact of informal trade made it possible to determine the impact of informal trade on the "Mariscal de Puyo" market using Neutrosophy theory. We reached to the conclusion that informal trade gains space in the Ecuadorian trade network.

By applying the method in a real context, we validated this technique for evaluating the impact of informal trade with the use of information aggregation operators. The proposal can be extended to work with other multi-criteria methods for inference processing where the results obtained by the different methods can be compared.

References

1. Ricardo, J.E., M.L. Poma, A.A. Pazmiño, A.A. Navarro, L.M. Estévez, and N.B. Hernandez, Neutrosophic model to determine the degree of comprehension of higher education students in Ecuador. Neutrosophic Sets & Systems, 2019. 26.
2. Teltscher, S., Small trade and the world economy: Informal vendors in Quito, Ecuador. Economic Geography, 1994. 70(2): p. 167-187.
3. Middleton, A., Informal traders and planners in the regeneration of historic city centres: the case of Quito, Ecuador. Progress in Planning, 2003. 59(2): p. 71-123.

4. Waters, W.F., The road of many returns: rural bases of the informal urban economy in Ecuador. Latin American Perspectives, 1997. 24(3): p. 50-64.
5. Lanjouw, J.O. and P.I. Levy, Untitled: A study of formal and informal property rights in urban Ecuador. The Economic Journal, 2002. 112(482): p. 986-1019.
6. Kromann, P., F. Montesdeoca, and J. Andrade-Piedra, Integrating formal and informal potato seed systems in Ecuador. Case studies of roots, tubers and bananas seed systems, 2016: p. 2016-3.
7. Canelas, C., Informality and poverty in Ecuador. Small Business Economics, 2019. 53(4): p. 1097-1115.
8. Gamble, J. and E. Puga, Is Informal Transit Land-Oriented? Investigating the Links Between Informal Transit and Land-Use Planning in Quito, Ecuador. 2019.
9. Gamble, J. and C. Dávalos, Moving with masculine care in the city: Informal transit in Quito, Ecuador. City, 2019. 23(2): p. 189-204.
10. Le, C., Preamble to Neutrosophy and Neutrosophic Logic. MULTIPLE VALUED LOGIC, 2002. 8(3): p. 285-296.
11. Leyva-Vázquez, M., F. Smarandache, and J.E. Ricardo, Artificial intelligence: challenges, perspectives and neutrosophy role.(Master Conference). Dilemas Contemporáneos: Educación, Política y Valore, 2018. 6(Special).
12. Ponce Ruiz, D.V., J.C. Albarracín Matute, E.J. Jalón Arias, L.O. Albarracín Zambrano, L.J. Molina Chalacán, Í.M. Serrano Quevedo, and A.R. Zuñiga Paredes, Softcomputing in neutrosophic linguistic modeling for the treatment of uncertainty in information retrieval. Neutrosophic Sets & Systems, 2019. 26.
13. Fernández, S.H.d.M. Criterio de expertos. Su procesamiento a través del método Delphy. Histodidáctica 2016; Available from: http://www.ub.edu/histodidactica/index.php?option=com_content&view=article&id=21:criterio-de-expertos-su-procesamiento-a-traves-del-metodo-delphy&catid=11:.
14. Leyva-Vázquez, M. and F. Smarandache, Neutrosophy: New advances in the treatment of the uncertainty (Neutrosofía: Nuevos avances en el tratamiento de la incertidumbre)(In Spanish). 2018, Brussels: Pons.
15. Ashbacher, C., Introduction to Neutrosophic Logic. 2002, Rehoboth: American Research Press.
16. Chen, Z.-S., K.-S. Chin, and K.-L. Tsui, Constructing the geometric Bonferroni mean from the generalized Bonferroni mean with several extensions to linguistic 2-tuples for decision-making. Applied Soft Computing, 2019. 78: p. 595-613.
17. Giráldez-Cru, J., M. Chica, O. Cordón, and F. Herrera, Modeling agent-based consumers decision-making with 2-tuple fuzzy linguistic perceptions. International Journal of Intelligent Systems, 2020. 35(2): p. 283-299.
18. Schmied, S., D. Großmann, S.G. Mathias, and S. Banerjee. Vertical Integration via Dynamic Aggregation of Information in OPC UA. in Asian Conference on Intelligent Information and Database Systems. 2020. Springer.
19. Schultz, P.T., R.A. Sartini, and M.W. Mckee, Aggregation and use of information relating to a users context for personalized advertisements. 2019, Google Patents.
20. Gospodinov, N. and E. Maasoumi, Generalized Aggregation of Misspecified Models: With An Application to Asset Pricing. 2019.
21. He, X., Typhoon disaster assessment based on Dombi hesitant fuzzy information aggregation operators. Natural Hazards, 2018. 90(3): p. 1153-1175.
22. Cornelio, O.M., I.S. Ching, J.G. Gulín, and L. Rozhnova, Competency assessment model for a virtual laboratory system at distance using fuzzy cognitive map. Investigación Operacional, 2018. 38(2): p. 169-177.
23. Liu, P., H. Xu, and Y. Geng, Normal wiggly hesitant fuzzy linguistic power Hamy mean aggregation operators and their application to multi-attribute decision-making. Computers & Industrial Engineering, 2020. 140: p. 106224.
24. Yager, R.R. and D.P. Filev, Induced ordered weighted averaging operators. IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics), 1999. 29(2): p. 141-150.
25. Sampson, T.R., C. Challis, N. Jain, A. Moiseyenko, M.S. Ladinsky, G.G. Shastri, T. Thron, B.D. Needham, I. Horvath, and J.W. Debelius, A gut bacterial amyloid promotes α-synuclein aggregation and motor impairment in mice. Elife, 2020. 9: p. e53111.
26. Mar, O., I. Ching, and J. González, Operador por selección para la agregación de información en Mapa Cognitivo Difuso. Revista Cubana de Ciencias Informáticas, 2020. 14(1): p. 20-39.
27. Jin, L., R. Mesiar, and R. Yager, Ordered weighted averaging aggregation on convex poset. IEEE Transactions on Fuzzy Systems, 2019. 27(3): p. 612-617.

28. Sha, X., Z. Xu, and C. Yin, Elliptical distribution-based weight-determining method for ordered weighted averaging operators. International Journal of Intelligent Systems, 2019. 34(5): p. 858-877.

29. Garg, H., N. Agarwal, and A. Tripathi, Choquet integral-based information aggregation operators under the interval-valued intuitionistic fuzzy set and its applications to decision-making process. International Journal for Uncertainty Quantification, 2017. 7(3).

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