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Prioritization internal factors in the emergency service of the "Luis Gabriel Dávila" Hospital that cause the re-entry of patients within 48 hours, based on neutrosophic DEMATEL

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Abstract. A high incidence of patient readmission in a hospital is a public health problem to consider. This investigation aims to address this problem at the "Luis Gabriel Dávila" hospital in the Province of Carchi, Ecuador, in its emergency area, where readmission incidence is considered in a time span of 48 hours. For this end, Neutrosophic DEMATEL method was used as the technique that studies the cause-effect relationships to allow decision-making in the problems solution of this type. Neutrosophic DEMATEL includes the modeling of indeterminacy due to the lack of information, or contradictory, paradoxical or inconsistent information. This paper uses a scale of linguistic terms, which is an advantage for experts to emit their criteria. A team of three experts is selected, who evaluated twelve factors related to this topic.

Keywords: patient readmission, Neutrosophic DEMATEL, single-valued trapezoidal neutrosophic number, single-valued triangular neutrosophic number.

1 Introduction

The present study was carried out in the Province of Carchi, Canton Tulcán, in the Hospital "Luis Gabriel Dávila" emergency area, where the high incidence of patient readmissions related to the complication and progression of the disease was evidenced. There is considered as objective, to implement intervention strategies on internal factors in the emergency service, thus contributing to risk factors reduction that occur at the time of admission to a hospital unit. When analyzing different investigations, it was confirmed that the personnel who works within the service believes that knowledge about the causes of patient readmission is limited, which creates a problem for their care; see [1].

Hospital readmissions represent a public health problem, given that they are due to complex relationships between health status and functionality, in-hospital care and management, interactions between the patient, his (her) family environment and the community; see [2-3].

It is very important to know that when analyzing readmissions, there is a need to have valid information on the quality of care, since this has led to the monitoring of various clinical indicators in other investigations that allow detecting failures in health systems related to hospital readmissions. In hospital emergency services, it has been proposed to use the 'emergency return rate' as an indicator of quality, along with others such as 'voluntary discharge', 'mortality' or 'claims'.

When reviewing some current research, it is identified that the results were shown in proportion to the fact that hospital readmissions are frequent, potentially preventable, costly events associated with high morbidity and mortality. There exist few papers that have investigated the causes of hospital readmissions; the most classical is the publication in 1990 by Pierce et al., see [4][1], which classified its causes into 4 groups, viz., 'related to the patient', 'the doctor', 'the health system' and 'the disease'.

Other authors have used a classification in three groups of causes: 'related to the patient', 'the doctor' and 'the disease'. Over the years, research on hospital readmissions has changed its approach and opened the way to new information; according to Caballero et al., see [5][2], they have described new factors associated with hospital readmissions, such as: hospital stay, severity of the disease, co-morbidities, number of pre-emergency or hospitalizations, male sex, being over 65 years and deficiencies in care.

In analyzing a research conducted in the United States, readmission policies, as well as clinical interventions to reduce them, have focused mainly on health plans, to improve the quality of care and solve the potential problems of patients, and others are increasingly committed to broad population-based strategies that will optimize the transitions of care and health of all people, regardless of their age.

According to the National Development Plan A Lifetime in Ecuador, Objective 1 indicates guaranteeing a dignified life with equal opportunities for all people. On the other hand, it mentions that health "is constituted as a fundamental component of a dignified life, since it has such a repercussion at the individual level and in the collective as well. The absence of it can bring inter-generational effects. This integral vision of health and its determinants urges to provide the conditions for the enjoyment of health in an integral manner, which includes not only physical but also mental health. The people's mental health requires significant attention to face growing problems, such as disorders related to depression and anxiety, which limit and condition the potential of a society for its development", see [6].

In Ecuador there exist few readmission publications and the impact they generate on resources and the provision of health services. This study aims to establish the main causes of hospital readmission, internal factors in the provision of services and improve the quality of care provided by health personnel within the emergency service. Integrating information from clinical-administrative databases of hospital care improves the ability to identify factors associated with an increased risk of patient readmission that could be used to propose strategies and a possible solution to the problem.

The mathematical model utilized to solve this problem is Neutrosophic DEMATEL. DEMATEL is a method consisting in a cause-effect matrix among a set of factors, containing the level of influence of each other, see [7-11]. A final matrix is obtained indicating the importance of every one of these factors, and also a causal diagram can be depicted to represent the weight of them. Neutrosophic DEMATEL is the neutrosophic approach to this method, where the indeterminacy is including for modelling by means of the single-valued trapezoidal neutrosophic number; see [12]. The single-valued trapezoidal neutrosophic number contains three membership functions, one representing truthfulness, a second one representing indeterminacy and a third one representing falseness, all of them having a trapezoidal shape, see [13][3].

In this paper we use a linguistic neutrosophic scale to measure the degree of influence of every pair of factors. This is an advantage, because natural language is more comprehensible for experts than a numeric one. Moreover, neutrosophic numbers are more accurate than fuzzy or fuzzy intuitionistic ones.

The present paper is divided as follows; the first section is devoted to expose the main concepts and the Neutrosophic DEMATEL method. Next, a section of Results shows the calculations we made to solve the problem, and finally, last section contains the conclusions.

2 Preliminaries

This section exposes the main definitions and the Neutrosophic DEMATEL method itself. The point of depart in the DEMATEL method is a cause-effect matrix containing the degree of influence of every factor over the others, provided by an experts' group. Particularly, Neutrosophic DEMATEL uses calculus based on single-valued trapezoidal neutrosophic numbers, see Definition 1.

Definition 1. ([13-15]) Suppose $\alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \in [0,1]$ and $a_1, a_2, a_3, a_4 \in \mathbb{R}$, where $a_1 \leq a_2 \leq a_3 \leq a_4$. Then, a single-valued trapezoidal neutrosophic number $a = (a_1, a_2, a_3, a_4)$; $\alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}}$ is a special neutrosophic set on the real line set $\mathbb{R}$, whose truth-membership, indeterminacy-membership and falsity-membership functions are defined as:

$$T_{\tilde{a}}(x) = \begin{cases} \alpha_{\tilde{a}}\left(\frac{x-a_1}{a_2-a_1}\right), & a_1 \leq x \leq a_2 \\ \alpha_{\tilde{a}}, & a_2 \leq x \leq a_3 \\ \alpha_{\tilde{a}}\left(\frac{a_4-x}{a_4-a_3}\right), & a_3 \leq x \leq a_4 \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

$$I_{\tilde{a}}(x) = \begin{cases} \frac{(a_2 - x + \beta_{\tilde{a}}(x - a_1))}{a_2 - a_1}, & a_1 \leq x \leq a_2 \\ \beta_{\tilde{a}}, & a_2 \leq x \leq a_3 \\ \frac{(x - a_2 + \beta_{\tilde{a}}(a_4 - x))}{a_4 - a_3}, & a_3 \leq x \leq a_4 \\ 1, & \text{otherwise} \end{cases} \quad (2)$$

$$F_{\tilde{a}}(x) = \begin{cases} \frac{(a_2 - x + \gamma_{\tilde{a}}(x - a_1))}{a_2 - a_1}, & a_1 \leq x \leq a_2 \\ \gamma_{\tilde{a}}, & a_2 \leq x \leq a_3 \\ \frac{(x - a_3 + \gamma_{\tilde{a}}(a_4 - x))}{a_4 - a_3}, & a_3 \leq x \leq a_4 \\ 1, & \text{otherwise} \end{cases} \quad (3)$$

Where $\alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}}$ typify the maximum truth-membership degree, the minimum indeterminacy-membership degree and the minimum falsity-membership degree, respectively. A single-valued trapezoidal neutrosophic number $a = (a_1, a_2, a_3, a_4)$; $\alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}}$ may express an imprecise quantity of the range, which it approximately equals to the interval $[a_2, a_3]$.

Definition 2. ([13-15]) Let $\tilde{a} = \langle (a_1, a_2, a_3); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle$; $\alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}}$ and $\tilde{b} = \langle (b_1, b_2, b_3); \alpha_{\tilde{b}}, \beta_{\tilde{b}}, \gamma_{\tilde{b}} \rangle$; $\alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}}$ be two single-valued trapezoidal neutrosophic numbers, and λ be any real number. Then we have the following operations:

1. Addition of two trapezoidal neutrosophic numbers:

$$\tilde{a} + \tilde{b} = \langle (a_1 + b_1, a_2 + b_2, a_3 + b_3, a_4 + b_4); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle$$

2. Subtraction of two trapezoidal neutrosophic numbers:

$$\tilde{a} - \tilde{b} = \langle (a_1 - b_4, a_2 - b_3, a_3 - b_2, a_4 - b_1); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle$$

3. Inverse of trapezoidal neutrosophic numbers:

$$\tilde{a}^{-1} = \langle ({a_4}^{-1}, {a_3}^{-1}, {a_2}^{-1}, {a_1}^{-1}); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle, \text{ where } a_1, a_2, a_3, a_4 \neq 0.$$

4. Multiplication of trapezoidal neutrosophic numbers by a constant value:

$$\lambda\tilde{a} = \begin{cases} \langle (\lambda a_1, \lambda a_2, \lambda a_3, \lambda a_4); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle, & \lambda > 0 \\ \langle (\lambda a_4, \lambda a_3, \lambda a_2, \lambda a_1); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle, & \lambda < 0 \end{cases}$$

5. Division of two trapezoidal neutrosophic numbers:

$$\frac{\tilde{a}}{\tilde{b}} = \begin{cases} \langle \left(\frac{a_1}{b_4}, \frac{a_2}{b_3}, \frac{a_3}{b_2}, \frac{a_4}{b_1}\right); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle, a_4 > 0 \text{ and } b_4 > 0 \\ \langle \left(\frac{a_4}{b_4}, \frac{a_3}{b_3}, \frac{a_2}{b_2}, \frac{a_1}{b_1}\right); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle, a_4 < 0 \text{ and } b_4 > 0 \\ \langle \left(\frac{a_4}{b_1}, \frac{a_3}{b_2}, \frac{a_2}{b_3}, \frac{a_1}{b_4}\right); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle, a_4 < 0 \text{ and } b_4 < 0 \end{cases}$$

6. Multiplication of trapezoidal neutrosophic numbers:

$$\tilde{a}\tilde{b} = \begin{cases} \langle (a_1 b_1, a_2 b_2, a_3 b_3, a_4 b_4); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle, & a_4 > 0 \text{ and } b_4 > 0 \\ \langle (a_1 b_4, a_2 b_3, a_3 b_2, a_4 b_1); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle, & a_4 < 0 \text{ and } b_4 > 0 \\ \langle (a_4 b_4, a_3 b_3, a_2 b_2, a_1 b_1); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle, & a_4 < 0 \text{ and } b_4 < 0 \end{cases}$$

The Neutrosophic DEMATEL analysis is explained as follows, see [12]:
Step1. Identifying decision goals: collecting relevant information presenting the problem.
1. Selection of experts and decision makers that have experience in the field.

2. Identifying the relevant criteria to the problem.

Step 2. Pair-wise comparison matrices between relevant criteria.

1. Identify the criteria, Criteria = (F_1, F_2, F_3,…, F_n).

2. Experts make pair-wise comparisons matrices between criteria.

a. Interpret each value for each criterion compared to other one in a trapezoidal neutrosophic number (l_{jk},m_{jkl},m_{jku},u_{jk}), j,k = {1,2,…,n}.

b. Make comparisons between criteria by each expert as shown in Table 1.

c. Focuses only on (n−1) consensus judgments using a scale from 0 to 1.

3. Experts should determine the maximum truth-membership degree (α), the minimum indeterminacy-membership degree (β) and the minimum falsity-membership degree (γ) of single-valued neutrosophic numbers as shown in Table 2.

4. Determine the crisp value of each opinion as shown in Table 3, using Equations 4 or 5:

Criteria	F_1	F_2	…	F_n
F_1	(l_{11},m_{11l},m_{11u},u_{11})	(l_{12},m_{12l},m_{12u},u_{12})	…	(l_{1n},m_{1nl},m_{1nu},u_{1n})
F_2	(l_{21},m_{21l},m_{21u},u_{21})	(l_{22},m_{22l},m_{22u},u_{22})	…	(l_{2n},m_{2nl},m_{2nu},u_{2n})
…	…	…	…	…
F_n	(l_{n1},m_{n1l},m_{n1u},u_{n1})	(l_{n2},m_{n2l},m_{n2u},u_{n2})	…	(l_{nn},m_{nnl},m_{nnu},u_{nn})

Table 1: The pair-wise comparison matrix between criteria.

Criteria	F_1	F_2	…	F_n
F_1	(l_{11},m_{11l},m_{11u},u_{11}; α_{11},β_{11},γ_{11})	(l_{12},m_{12l},m_{12u},u_{12}; α_{12},β_{12},γ_{12})	…	(l_{1n},m_{1nl},m_{1nu},u_{1n}; α_{1n},β_{1n},γ_{1n})
F_2	(l_{21},m_{21l},m_{21u},u_{21}; α_{21},β_{21},γ_{21})	(l_{22},m_{22l},m_{22u},u_{22}; α_{22},β_{22},γ_{22})	…	(l_{2n},m_{2nl},m_{2nu},u_{2n}; α_{2n},β_{2n},γ_{2n})
…	…	…	…	…
F_n	(l_{n1},m_{n1l},m_{n1u},u_{n1}; α_{n1},β_{n1},γ_{n1})	(l_{n2},m_{n2l},m_{n2u},u_{n2}; α_{n2},β_{n2},γ_{n2})	…	(l_{nn},m_{nnl},m_{nnu},u_{nn}; α_{nn},β_{nn},γ_{nn})

Table 2: The pair-wise comparison matrix between criteria with the α, β and γ degree.

Criteria	F_1	F_2	…	F_n
F_1	CV_{11}	CV_{12}	…	CV_{1n}
F_2	CV_{21}	CV_{22}	…	CV_{2n}
…	…	…	…	…
F_n	CV_{n1}	CV_{n2}	…	CV_{nn}

Table 3: The crisp values of comparison matrix.

Criteria	F_1	F_2	…	F_n
F_1	$\overline{CV}_{11}$	$\overline{CV}_{12}$	…	$\overline{CV}_{1n}$
F_2	$\overline{CV}_{21}$	$\overline{CV}_{22}$	…	$\overline{CV}_{2n}$
…	…	…	…	…
F_n	$\overline{CV}_{n1}$	$\overline{CV}_{n2}$	…	$\overline{CV}_{nn}$

Table 4: Integration of the average opinions of all experts.

$$S(\tilde{a}_{ij}) = \frac{1}{16}[a_1 + b_1 + c_1 + d_1](2 + \alpha_{\tilde{a}} - \beta_{\tilde{a}} - \gamma_{\tilde{a}}) \quad (4)$$

$$A(\tilde{a}_{ij}) = \frac{1}{16}[a_1 + b_1 + c_1 + d_1](2 + \alpha_{\tilde{a}} - \beta_{\tilde{a}} + \gamma_{\tilde{a}}) \quad (5)$$

Step 3. Integration of matrices. All opinions of experts need to be integrated into one matrix presenting the average opinions of all experts about each criterion, as shown in Table 4 using Equation 6.

$$\overline{CV}_{lm} = \frac{\sum_{j=1}^{k} CV_{lmi}}{k} \quad (6)$$

Where k is the number of experts and CV_{lmi} is the crisp value in Table 3 corresponding to expert i. We obtain the average for all values as in the matrix in Table 4.

Step 4. Generating the direct relation matrix.

This matrix is obtained from previous Step 3, i.e. the integrating of all averaged opinions of experts. An initial direct relation matrix A is a n×n matrix obtained by pair-wise comparisons, $S = [s_{ij}]_{n\times n}$. S_{ij} denotes the degree to which the criterion i affects the criterion j.

Step 5. Normalizing the direct relation matrix.

The normalized direct relation matrix can be obtained using the Equation 7 and 8:

$$K = \frac{1}{\max_{1\le i\le n}\sum_{j=1}^{n} a_{ij}} \qquad (7)$$

$$S = K \times A \qquad (8)$$

Step 6. Attaining the total relation matrix. The total relation matrix is acquired using the formula 9 from the generalized direct relation matrix S. A total relation matrix (T), in which 'I' denotes the identity matrix, is shown as follows:

$$T = S(I - S)^{-1} \qquad (9)$$

Step 7. Obtaining the sum of rows and columns.

The sum of rows of T is denoted by D, and the sum of columns is denoted by R. Calculate R+D and D-R. Calculate T, where $T= [a_{ij}]_{n\times n}$, i, j=1, 2… n.

$$D = \left[\sum_{i=1}^{n} a_{ij}\right]_{1\times n} = \left[a_j\right]_{n\times 1} \qquad (10)$$

$$R = \left[\sum_{j=1}^{n} a_{ij}\right]_{1\times n} = [a_i]_{n\times 1} \qquad (11)$$

Step 8. Drawing cause and effect diagram

The causal diagram is obtained by the horizontal axes is presented by (D+R) and the vertical axes (D−R) which is a degree of relation and it depicts the steps of proposed model.

Remark 1. Let us observe that we can reduce the complexity of the calculus if the single-valued trapezoidal neutrosophic numbers are converted to single-valued triangular neutrosophic numbers, where $a_2 = a_3$ in Equations 1, 2 and 3, see [16].

Additionally, we use the neutrosophic linguistic scale summarized in Table 5 to assess the criteria.

Linguistic Term	Single-valued triangular neutrosophic number
No influence (NI)	$\tilde{0} = \langle(0,0,0); 0.50, 0.50, 0.50\rangle$
Very low influence (VLI)	$\tilde{1} = \langle(0,1,2); 0.30, 0.75, 0.70\rangle$
Low influence (LI)	$\tilde{2} = \langle(1,2,3); 0.80, 0.15, 0.20\rangle$
High influence (HI)	$\tilde{3} = \langle(2,3,4); 0.90, 0.10, 0.10\rangle$
Very high influence (VHI)	$\tilde{4} = \langle(4,4,4); 1.00, 0.00, 0.00\rangle$

Table 5: Linguistic terms used to measure influences and their corresponding Single-valued triangular neutrosophic number.

3 Results

In this section Neutrosophic DEMATEL is applied to the problem on the emergency service of the "Luis Gabriel Dávila" hospital that causes the readmission of patients within 48 hours. We start identifying the main factors that affect this phenomenon; they are summarized in Table 6, see [1][4].

Causes related to the patient	F_1: Therapeutic breach
	F_2:Psychiatric disorder
	F_3:Volunteer registration or fugue without being seen by a doctor
	F_4:Regular use of Hospital Urgency System for non-urgent problems
	F_5:Anxiety
Causes related to professionals	F_6:Error in diagnosis or treatment error
	F_7:Initialy patient must have entered in emergency
	F_8:Instructions to return or patient was called to return
Causes related to system	F_9:No specialist available
Causes related to the disease	F_{10}:Disease progression and disease recurrence

F_{11}:Complication

F_{12}:New problem

Table 6: The most important factors that cause the readmission problem.

Three experts were selected to form the cause-effect matrix based on the linguistic scale in Table 6. Tables 7, 8 and 9 contain their assessments.

Factor	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}	F_{11}	F_{12}
F_1	$\tilde{0}$	$\tilde{1}$	$\tilde{3}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{3}$	$\tilde{4}$	$\tilde{4}$	$\tilde{3}$
F_2	$\tilde{3}$	$\tilde{0}$	$\tilde{3}$	$\tilde{3}$	$\tilde{3}$	$\tilde{0}$	$\tilde{1}$	$\tilde{0}$	$\tilde{0}$	$\tilde{2}$	$\tilde{2}$	$\tilde{2}$
F_3	$\tilde{1}$	$\tilde{0}$	$\tilde{2}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{3}$	$\tilde{1}$	$\tilde{3}$	$\tilde{3}$	$\tilde{3}$
F_4	$\tilde{3}$	$\tilde{0}$	$\tilde{2}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{4}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$
F_5	$\tilde{3}$	$\tilde{1}$	$\tilde{4}$	$\tilde{3}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{1}$
F_6	$\tilde{0}$	$\tilde{0}$	$\tilde{2}$	$\tilde{0}$	$\tilde{3}$	$\tilde{0}$	$\tilde{3}$	$\tilde{3}$	$\tilde{0}$	$\tilde{3}$	$\tilde{3}$	$\tilde{3}$
F_7	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{3}$	$\tilde{0}$	$\tilde{0}$	$\tilde{3}$	$\tilde{0}$	$\tilde{3}$	$\tilde{3}$	$\tilde{3}$
F_8	$\tilde{3}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{2}$	$\tilde{0}$	$\tilde{1}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$
F_9	$\tilde{3}$	$\tilde{0}$	$\tilde{3}$	$\tilde{3}$	$\tilde{3}$	$\tilde{4}$	$\tilde{3}$	$\tilde{3}$	$\tilde{0}$	$\tilde{3}$	$\tilde{3}$	$\tilde{3}$
F_{10}	$\tilde{2}$	$\tilde{0}$	$\tilde{0}$	$\tilde{2}$	$\tilde{3}$	$\tilde{0}$	$\tilde{0}$	$\tilde{3}$	$\tilde{0}$	$\tilde{0}$	$\tilde{4}$	$\tilde{3}$
F_{11}	$\tilde{3}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{3}$	$\tilde{0}$	$\tilde{0}$	$\tilde{3}$	$\tilde{0}$	$\tilde{3}$	$\tilde{0}$	$\tilde{3}$
F_{12}	$\tilde{3}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{3}$	$\tilde{0}$	$\tilde{0}$	$\tilde{3}$	$\tilde{0}$	$\tilde{3}$	$\tilde{3}$	$\tilde{0}$

Table 7: The pair-wise comparison matrix between criteria corresponding to Expert 1.

Factor	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}	F_{11}	F_{12}
F_1	$\tilde{0}$	$\tilde{0}$	$\tilde{2}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{0}$	$\tilde{4}$	$\tilde{4}$	$\tilde{4}$	$\tilde{4}$
F_2	$\tilde{3}$	$\tilde{0}$	$\tilde{4}$	$\tilde{2}$	$\tilde{2}$	$\tilde{0}$	$\tilde{2}$	$\tilde{1}$	$\tilde{1}$	$\tilde{3}$	$\tilde{1}$	$\tilde{1}$
F_3	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{1}$	$\tilde{0}$	$\tilde{0}$	$\tilde{4}$	$\tilde{0}$	$\tilde{4}$	$\tilde{2}$	$\tilde{4}$
F_4	$\tilde{4}$	$\tilde{0}$	$\tilde{1}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{1}$	$\tilde{3}$	$\tilde{1}$	$\tilde{1}$	$\tilde{0}$
F_5	$\tilde{2}$	$\tilde{2}$	$\tilde{4}$	$\tilde{2}$	$\tilde{0}$	$\tilde{1}$	$\tilde{1}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{1}$	$\tilde{0}$
F_6	$\tilde{0}$	$\tilde{1}$	$\tilde{1}$	$\tilde{0}$	$\tilde{2}$	$\tilde{0}$	$\tilde{2}$	$\tilde{4}$	$\tilde{0}$	$\tilde{2}$	$\tilde{2}$	$\tilde{4}$
F_7	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{4}$	$\tilde{1}$	$\tilde{0}$	$\tilde{4}$	$\tilde{1}$	$\tilde{2}$	$\tilde{3}$	$\tilde{2}$
F_8	$\tilde{2}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{0}$	$\tilde{0}$	$\tilde{1}$	$\tilde{0}$	$\tilde{1}$
F_9	$\tilde{2}$	$\tilde{0}$	$\tilde{2}$	$\tilde{2}$	$\tilde{3}$	$\tilde{3}$	$\tilde{4}$	$\tilde{4}$	$\tilde{0}$	$\tilde{2}$	$\tilde{2}$	$\tilde{2}$
F_{10}	$\tilde{3}$	$\tilde{0}$	$\tilde{0}$	$\tilde{2}$	$\tilde{2}$	$\tilde{1}$	$\tilde{1}$	$\tilde{4}$	$\tilde{0}$	$\tilde{0}$	$\tilde{3}$	$\tilde{4}$
F_{11}	$\tilde{2}$	$\tilde{1}$	$\tilde{0}$	$\tilde{0}$	$\tilde{4}$	$\tilde{0}$	$\tilde{0}$	$\tilde{2}$	$\tilde{1}$	$\tilde{4}$	$\tilde{0}$	$\tilde{4}$
F_{12}	$\tilde{4}$	$\tilde{1}$	$\tilde{1}$	$\tilde{0}$	$\tilde{2}$	$\tilde{0}$	$\tilde{1}$	$\tilde{2}$	$\tilde{0}$	$\tilde{2}$	$\tilde{2}$	$\tilde{0}$

Table 8: The pair-wise comparison matrix between criteria corresponding to Expert 2.

Factor	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}	F_{11}	F_{12}
F_1	$\tilde{0}$	$\tilde{0}$	$\tilde{2}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{1}$	$\tilde{1}$	$\tilde{4}$	$\tilde{3}$	$\tilde{3}$	$\tilde{4}$
F_2	$\tilde{2}$	$\tilde{0}$	$\tilde{2}$	$\tilde{3}$	$\tilde{4}$	$\tilde{1}$	$\tilde{2}$	$\tilde{0}$	$\tilde{0}$	$\tilde{1}$	$\tilde{3}$	$\tilde{1}$
F_3	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{1}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{2}$	$\tilde{0}$	$\tilde{2}$	$\tilde{2}$	$\tilde{2}$
F_4	$\tilde{2}$	$\tilde{1}$	$\tilde{1}$	$\tilde{0}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{3}$	$\tilde{1}$	$\tilde{0}$	$\tilde{0}$
F_5	$\tilde{2}$	$\tilde{2}$	$\tilde{3}$	$\tilde{4}$	$\tilde{0}$	$\tilde{1}$	$\tilde{1}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{2}$
F_6	$\tilde{0}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{2}$	$\tilde{0}$	$\tilde{2}$	$\tilde{2}$	$\tilde{1}$	$\tilde{2}$	$\tilde{3}$	$\tilde{2}$
F_7	$\tilde{0}$	$\tilde{1}$	$\tilde{0}$	$\tilde{1}$	$\tilde{4}$	$\tilde{0}$	$\tilde{0}$	$\tilde{4}$	$\tilde{0}$	$\tilde{2}$	$\tilde{4}$	$\tilde{3}$
F_8	$\tilde{2}$	$\tilde{0}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{0}$	$\tilde{2}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$
F_9	$\tilde{4}$	$\tilde{0}$	$\tilde{2}$	$\tilde{2}$	$\tilde{2}$	$\tilde{3}$	$\tilde{4}$	$\tilde{4}$	$\tilde{0}$	$\tilde{2}$	$\tilde{2}$	$\tilde{2}$
F_{10}	$\tilde{3}$	$\tilde{0}$	$\tilde{0}$	$\tilde{1}$	$\tilde{2}$	$\tilde{1}$	$\tilde{0}$	$\tilde{4}$	$\tilde{0}$	$\tilde{0}$	$\tilde{3}$	$\tilde{4}$
F_{11}	$\tilde{3}$	$\tilde{0}$	$\tilde{1}$	$\tilde{0}$	$\tilde{2}$	$\tilde{0}$	$\tilde{0}$	$\tilde{2}$	$\tilde{0}$	$\tilde{4}$	$\tilde{0}$	$\tilde{4}$
F_{12}	$\tilde{4}$	$\tilde{0}$	$\tilde{0}$	$\tilde{0}$	$\tilde{4}$	$\tilde{0}$	$\tilde{0}$	$\tilde{2}$	$\tilde{1}$	$\tilde{4}$	$\tilde{2}$	$\tilde{0}$

Table 9: The pair-wise comparison matrix between criteria corresponding to Expert 3.

Table 10, 11 and 12 contain the crisp values of comparison matrices for Experts 1, 2 and 3 respectively, using Equation 12, which is based on Equation 5 for single-valued triangular neutrosophic numbers.

$$A(\tilde{a}_{ij}) = \frac{1}{8}[a_1 + b_1 + c_1](2 + \alpha_{\tilde{a}} - \beta_{\tilde{a}} + \gamma_{\tilde{a}}) \quad (12)$$

For calculation we use the free software Octave 4.2.1, see [17].

Factor	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}	F_{11}	F_{12}
F_1	0	0.84	3.26	0	0	0	0	0	3.26	4.5	4.5	3.26
F_2	3.26	0	3.26	3.26	3.26	0	0.84	0	0	2.14	2.14	2.14
F_3	0.84	0	0	0	0	0	0	3.26	0.84	3.26	3.26	3.26
F_4	3.26	0	2.14	0	0	0	0	0	4.5	0	0	0
F_5	3.26	0.84	4.5	3.26	0	0	0	0	0	0	0	0.84
F_6	0	0	2.14	0	3.26	0	3.26	3,26	0	3.26	3.26	3.26
F_7	0	0	0	0	3.26	0	0	3.26	0	3.26	3.26	3.26
F_8	3.26	0	0	0	2.14	0	0.84	0	0	0	0	0
F_9	3.26	0	3.26	3.26	3.26	4.5	3.26	3.26	0	3.26	3.26	3.26
F_{10}	2.14	0	0	2.14	3.26	0	0	3.26	0	0	4.5	3.26
F_{11}	3.26	0	0	0	3.26	0	0	3.26	0	3.26	0	3.26
F_{12}	3.26	0	0	0	3.26	0	0	3.26	0	3.26	3.26	0

Table 10: Crisp values of comparison matrix for Expert 1.

Factor	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}	F_{11}	F_{12}
F_1	0	0	2.14	0.84	0.84	0.84	0.84	0	4.5	4.5	4.5	4.5
F_2	3.26	0	4.5	2.14	2.14	0	2.14	0.84	0.84	3.26	0.84	0.84
F_3	0	0	0	0	0.84	0	0	4.5	0	4.5	2.14	4.5
F_4	4.5	0	0.84	0	0	0	0	0.84	3.26	0.84	0.84	0
F_5	2.14	2.14	4.5	2.14	0	0.84	0.84	0	0	0	0.84	0
F_6	0	0.84	0.84	0	2.14	0	2.14	4.5	0	2.14	2.14	4.5
F_7	0	0	0	0	4.5	0.84	0	4.5	0.84	2.14	3.26	2.14
F_8	2.14	0	0	0	0.84	0.84	0.84	0	0	0.84	0	0.84
F_9	2.14	0	2.14	2.14	3.26	3.26	4.5	4.5	0	2.14	2.14	2.14
F_{10}	3.26	0	0	2.14	2.14	0.84	0.84	4.5	0	0	3.26	4.5
F_{11}	2.14	0.84	0	0	4.5	0	0	2.14	0.84	4.5	0	4.5
F_{12}	4.5	0.84	0.84	0	2.14	0	0.84	2.14	0	2.14	2.14	0

Table 11: Crisp values of comparison matrix for Expert 2.

Factor	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}	F_{11}	F_{12}
F_1	0	0	2.14	0	0	0	0.84	0.84	4.5	3.26	3.26	4.5
F_2	2.14	0	2.14	3.26	4.5	0.84	2.14	0	0	0.84	3.26	0.84
F_3	0	0	0	0.84	0	0	0	2.14	0	2.14	2.14	2.14
F_4	2.14	0.84	0.84	0	0.84	0.84	0.84	0.84	3.26	0.84	0	0
F_5	2.14	2.14	3.26	4.5	0	0.84	0.84	0	0	0	0	2.14
F_6	0	0.84	0.84	0.84	2.14	0	2.14	2.14	0.84	2.14	3.26	2.14
F_7	0	0.84	0	0.84	4.5	0	0	4.5	0	2.14	4.5	3.26
F_8	2.14	0	0.84	0.84	0.84	0	2.14	0	0	0	0	0
F_9	4.5	0	2.14	2.14	2.14	3.26	4.5	4.5	0	2.14	2.14	2.14
F_{10}	3.26	0	0	0.84	2.14	0.84	0	4.5	0	0	3.26	4.5
F_{11}	3.26	0	0.84	0	2.14	0	0	2.14	0	4.5	0	4.5
F_{12}	4.5	0	0	0	4.5	0	0	2.14	0.84	4.5	2.14	0

Table 12: Crisp values of comparison matrix for Expert 3.

Table 13 is the matrix of the three experts' averaged evaluations; see Equation 6.

Factor	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}	F_{11}	F_{12}
F_1	0	0.28	2.51	0.28	0.28	0.28	0.56	0.28	4.09	4.09	4.09	4.09
F_2	2.89	0	3.3	2.89	3.3	0.28	1.71	0.28	0.28	2.08	2.08	1.27
F_3	0.28	0	0	0.28	0.28	0	0	3.3	0.28	3.3	2.51	3.3
F_4	3.3	0.28	1.27	0	0.28	0.28	0.28	0.56	3.67	0.56	0.28	0
F_5	2.51	1.71	4.09	3.3	0	0.56	0.56	0	0	0	0.28	0.99
F_6	0	0.56	1.27	0.28	2.51	0	2.51	3.3	0.28	2.51	2.89	3.3
F_7	0	0.28	0	0.28	4.09	0.28	0	4.09	0.28	2.51	3.67	2.89
F_8	2.51	0	0.28	0.28	1.27	0.28	1.27	0	0	0.28	0	0.28
F_9	3.3	0	2.51	2.51	2.89	3.67	4.09	4.09	0	2.51	2.51	2.51
F_{10}	2.89	0	0	1.71	2.51	0.56	0.28	4.09	0	0	3.67	4.09
F_{11}	2.89	0.28	0.28	0	3.3	0	0	2.51	0.28	4.09	0	4.09
F_{12}	4.09	0.28	0.28	0	3.3	0	0.28	2.51	0.28	3.3	2.51	0

Table 13: Averaged crisp values of comparison matrices for the three experts.

Applying Equation 7 we have K = 0.03268 and we obtained matrix S according to Equation 8, and T according to Equation 9. Thus, vectors D and R are obtained applying Equations 10 and 11, respectively, see Table 14. See also the depicted cause and effect diagram in Figure 1.

Factor	D	R	D+R	D-R
F_1	1.89	1.62	3.51	0.27
F_2	0.29	1.44	1.73	-1.16
F_3	1.08	0.93	2.01	0.16
F_4	0.81	0.91	1.72	-0.10
F_5	1.67	0.99	2.66	0.68
F_6	0.40	1.32	1.72	-0.92
F_7	0.70	1.23	1.93	-0.53
F_8	1.75	0.49	2.24	1.26
F_9	0.71	2.12	2.84	-1.41
F_{10}	1.84	1.35	3.18	0.49
F_{11}	1.75	1.26	3.01	0.49
F_{12}	1.98	1.21	3.19	0.76

Table 14: Vectors D, R, D+R and D-R.

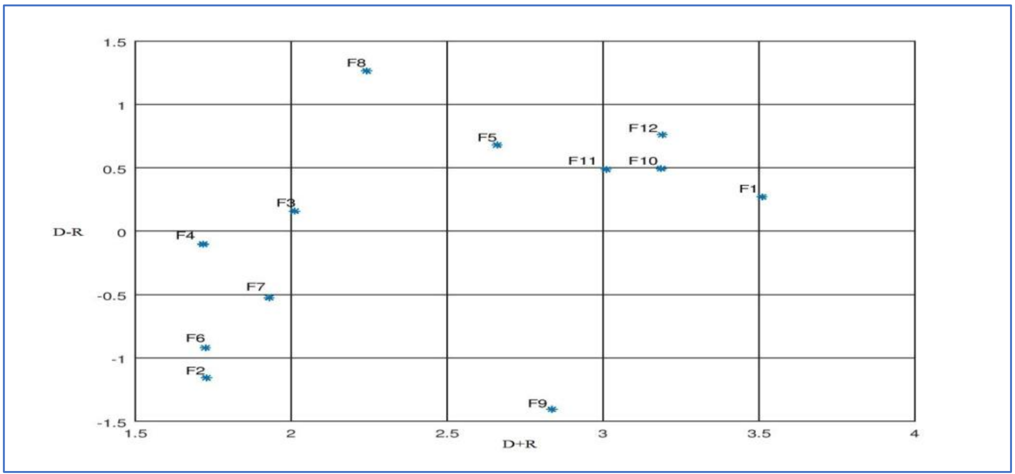

Figure 1: Cause and effect diagram.

According to the results in Table 14 and the diagram in Figure 1, we have that the most important factor in the entire system is F_1, followed by F_{12}, F_{10} and F_{11} in that order, because they have the biggest D+R index. Additionally, the net causes are F_1, F_3, F_5, F_8, F_{10}, F_{11}, F_{12}, while F_2, F_4, F_6, F_7, F_9 are the receivers; because factors in the first group have positive D-R values and those in the second group have negative values.

Therefore the “Therapeutic breach” is the most important cause and authorities in the hospital should pay attention to this factor. Additionally, we have that the causes related to the disease are the second more important.

Conclusion

This article was devoted to studying the problem of readmission in a time span of 48 hours in the hospital "Luis Gabriel Dávila" placed in Carchi province, Ecuador. Three experts evaluated the cause-effect relationship between twelve factors by using a scale based on linguistic terms. The Neutrosophic DEMATEL method was applied and it was concluded that "Therapeutic breach" is the most important cause to pay more attention to, while the causes related to the disease are the second most important.

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