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A MULTICRITERIA MODEL FOR THE SELECTION OF THE TRANSPORT SERVICE PROVIDER: A SINGLE VALUED NEUTROSOPHIC DEMATEL MULTICRITERIA MODEL

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Abstract: *The decision-making process requires, a priori, defining and considering certain factors, especially when it comes to complex areas such as transport management in companies. One of the most important items in the initial phase of the transport process that significantly influences its further flow is decision-making about the choice of the most favorable transport provider. In this paper a model for evaluating and selecting a transport service provider based on a single valued neutrosophic number (SVNN) is presented. The neutrosophic set concept represents a general platform that extends the concepts of classical sets, fuzzy sets, intuitionistic fuzzy sets, and an interval valued intuitionistic fuzzy sets. The application of the SVNN concept made a modification of the DEMATEL method (Decision-making Trial and Evaluation Laboratory Method) and proposed a model for ranking alternative solutions. The SVNN-DEMATEL model defines the mutual effects of the provider's evaluation criteria, while, in the second phase of the model, alternative providers are evaluated and ranked. The SVNN-DEMATEL model was tested on a hypothetical example of evaluation of five providers of transport services.*

Key Words: *Multicriteria Decision-making, DEMATEL, Single Valued Neutrosophic Numbers, Provider Selection*

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1. INTRODUCTION

Outsourcing approach is widely present in all logistic aspects of business, especially in the transport domain, which is distinguished by its significant and direct participation in overall logistics costs. After making a decision on accepting outsourcing for certain logistical activities of the organization, the management is facing the issue of selecting the provider that will implement these activities for the organization needs.

The problem of selecting a transport service provider is conceptually similar to the choice of providers in most other logistics activities. In that sense, when it comes to the models of selection of the transport service provider, of relevance are those research studies that are focused on the selection of carrier, suppliers, vendor, or independent logistics providers (third party logistics provider selection).

Regardless of differences in the views on the structuring of the providers selection problem (Ordoobadi & Wang, 2011; Shen & Yu, 2012), as well as on the structure of the selection process itself (Snir & Hitt, 2004; Monczka et al., 2005; Cao & Wang, 2007), when it comes to the nature of this process, its multidimensional character is often mentioned (Vinodh et al., 2011; Senthil et al., 2014). In that sense, numerous multicriteria decision-making methods have been used to select providers.

Various examples of combining different approaches that treat uncertainty (fuzzy access, etc.) with traditional multicriteria techniques, such as TOPSIS (Zouggari & Benyoucef, 2012; Senthil et al., 2014), VIKOR (Sanayei et al., 2010), AHP (Singh & Sharma, 2011; Senthil et al., 2014), ANP (Nobar et al., 2011) etc. can be found in the literature. An example of the DEMATEL method application to the recognition of the relevant criteria as well as to the identification of their significance and causal relationships in the process of structuring a model for the supplier selection with carbon management competencies can be seen in (Hsu et al., 2013).

As can be seen in a review of the referential literature given here, most approaches prefer the use of traditional multicriteria decision-making (MCDM) models in combination with fuzzy techniques (Senthil et al., 2014). However, in the real world, the decision-maker may prefer attribute assessment by using linguistic variables instead of crisp values either due to his partial knowledge about attributes or the lack of information from the problem domain. The Fuzzy set presented by Zadeh (1965) is one of the tools used to present such imprecision in mathematical form. However, the fuzzy set can focus only on the degree of affiliation of unclear parameters or events. The Fuzzy set cannot represent the degree of non-affiliation and the degree of imprecision of uncertainty parameters. In order to partially overcome the difficulties in defining parameters that are imprecise, Atanassov (1986) introduced intuitionistic fuzzy sets (IFS) that are characterized by the degree of affiliation and non-affiliation simultaneously. However, in the IFS, the sum of the affiliation degree and non-affiliation degree of the unclear parameter is less than one (unity). In order to eliminate these shortcomings, Smarandache (1998) introduced a neutrosophic concept in order to deal with unspecified or inconsistent information that usually exists in reality. The concept of a neutrosophic set represents a general platform that extends the concepts of classical sets, fuzzy sets (Zadeh, 1965), intuitionistic fuzzy sets (Atanassov, 1986), and interval valued intuitionistic fuzzy sets (Atanassov & Gargov, 1989). Unlike intuitionistic fuzzy sets and interval valued intuitionistic fuzzy sets, in the neutrosophic set indeterminacy is explicitly characterized.

Using the advantages of the neutrosophic sets mentioned above, the original SVNN-DEMATEL model for the transport service provider evaluation was proposed in this paper. In the next section of work (section 2), the basic items of the SVNN are

presented. Thereafter, in the third section of the paper, an original VKO model based on SVNN was presented. Testing of the presented model was performed in the fourth section of the work.

2. NEUTROSOPHIC SETS

According to the definition of a neutrosophic set, neutrosophic set *A* is a universal set *X* characterized by function of affiliation describing truth-membership function $T_A(x)$, indeterminacy-membership function $I_A(x)$ and the function of falsity-membership $F_A(x)$. Where $T_A(x)$, $I_A(x)$ and $F_A(x)$ are real standard or non-standard subsets of $[^-0,1^+]$, each of the three neutrosophic components satisfy the condition that $T_A(x) \rightarrow [^-0,1^+]$, $I_A(x) \rightarrow [^-0,1^+]$ and $F_A(x) \rightarrow [^-0,1^+]$.

Set $I_A(x)$ can be used to present not only indeterminacy, but also unclearness, uncertainties, inaccuracies, errors, contradictions, the undefined, the unknown, incompleteness, redundancy, etc. (Biswas et al., 2016). In order to cover all unclear information, the degree of affiliation to the indeterminacy-membership degree can be subdivided into sub-components, such as "contradiction," "uncertainty," and "unknown" (Smarandache, 1998).

The sum of these three neutrosophic set affiliation functions $T_A(x)$, $I_A(x)$ and $F_A(x)$ should satisfy the following condition $^-0 \le T_A(x) + I_A(x) + F_A(x) \le 3^+$ (Biswas et al., 2016). The component of neutrosophic set A for all values $x \in X$ is determined by A^C so that $T_A^c(x) = 1^+ - T_A(x)$, $I_A^c(x) = 1^+ - I_A(x)$ and $F_A^c(x) = 1^+ - F_A(x)$. Neutrosophic set A is contained in another neutrosophic set B ($A \subseteq B$) if and only if for each value $x \in X$ the following conditions are satisfied $\inf T_A(x) \le \inf T_B(x)$, $\sup T_A(x) \le \sup T_B(x)$, $\inf I_A(x) \ge \inf I_B(x)$, $\sup I_A(x) \ge \sup I_B(x)$, $\inf F_A(x) \ge \inf F_B(x)$, and $\sup F_A(x) \ge \sup F_B(x)$.

Single valued neutrosophic sets (SVNS) are a special case of the neutrosophic set that can be used more successfully in modern scientific and engineering applications, compared to the classical neutrophic set. Basic arithmetic operations on SVNN that are significant for the mathematical background of the MCDM model can be looked in detail in (Wang et al., 2010; Deli & Şubaş, 2017).

3. SINGLE VALUED NEUTROSOPHIC DEMATEL METHOD

The DEMATEL method is a very suitable tool for designing and analyzing the structural model. And it can be achieved through the definition of cause-effect relationships between factors that are complex (Pamučar & Ćirović, 2015; Gigović et al., 2016). In order to comprehensively take into account the imprecision that exists in group decision-making, this paper performs a modification of the DEMATEL method by using the SVNS. In the next section the steps of the SVN-DEMATEL method are elaborated, namely:

Step 1: Factors expert analysis. Assuming that there are *m* experts and *n* factors (criteria) that are observed, each expert should determine the degree of influence of factor *i* on factor *j*. A comparative analysis of the pair of the *i* -th and *j* -th factor by the k-th expert is marked by d_{ij}^e, where $d_{ij}^e = \left\langle T_{ij}^e, I_{ij}^e, F_{ij}^e \right\rangle$, $\left(i = 1,\ldots,n;\ j = 1,\ldots,n\right)$ represents a neutrophic number that is being compared in the pairs of factors. The value of each

pair d_{ij}^e takes the values from a previously defined single valued neutrosophic linguistic scale. The response of the e-th expert is displayed by a single valued neutrosophic matrix of $D^e = \left\langle d^e{}_{ij} \right\rangle_{n\times n} = \left\langle T_{ij}^e, I_{ij}^e, F_{ij}^e \right\rangle_{n\times n}$, $\left(1 \le e \le m\right)$ rank, where m represents the total number of experts.

$$D^e = \begin{bmatrix} 0 & \left\langle T_{12}^e, I_{12}^e, F_{12}^e \right\rangle & \cdots & \left\langle T_{1n}^e, I_{1n}^e, F_{1n}^e \right\rangle \\ \left\langle T_{21}^e, I_{21}^e, F_{21}^e \right\rangle & 0 & \cdots & \left\langle T_{2n}^e, I_{2n}^e, F_{2n}^e \right\rangle \\ \vdots & \vdots & \ddots & \vdots \\ \left\langle T_{n1}^e, I_{n1}^e, F_{n1}^e \right\rangle & \left\langle T_{n2}^e, I_{n2}^e, F_{n2}^e \right\rangle & \cdots & 0 \end{bmatrix}_{nxn} \tag{1}$$

Where $\left\langle T_{ij}^e, I_{ij}^e, F_{ij}^e \right\rangle$ represents single valued neutrosophic linguistic expressions from a predefined linguistic scale which the expert e uses to represent his comparison in the pairs of criteria. Thus we get matrices D^1, D^2, ..., D^m which represent the matrices of responses from each of the m experts.

Step 2: Determination of weight coefficients of experts. It starts from the assumption that m experts $\left\{E_1, E_2, ..., E_m\right\}$ with assigned weight coefficients $\{\varpi_1, \varpi_2, ..., \varpi_m\}$, $0 \le \varpi_e \le 1$, $(e = 1, 2, ..., m)$ participate in the decision-making process. Suppose that: (1) each expert from the group of m has his own weighting coefficient, (2) the weight coefficients of the experts differ in value, and (3) condition $\sum_{e=1}^{m} \varpi_e = 1$ is satisfied. Then we can present the significance of each expert using linguistic variables from a predefined single valued neutrosophic linguistic scale.

If we denote a single valued neutrosophic number with $E_e = \left\langle T_e(x), I_e(x), F_e(x) \right\rangle$ which evaluates the significance of the e-expert, then the weight coefficient of the e-th expert can be determined using the expression (2), [17]

$$\varpi_e = \frac{1 - \sqrt{\left\{\left(1 - T_e(x)\right)^2 + \left(I_e(x)\right)^2 + \left(F_e(x)\right)^2\right\} / 3}}{\sum_{e=1}^{m}\left(1 - \sqrt{\left\{\left(1 - T_e(x)\right)^2 + \left(I_e(x)\right)^2 + \left(F_e(x)\right)^2\right\} / 3}\right)} \tag{2}$$

where $\sum_{e=1}^{m} \varpi_e = 1$, $\left(1 \le e \le m\right)$.

Step 3: Determination of the average responses matrix of the experts. On the basis of individual matrices of the answer of the m experts, we obtain a matrix of aggregated sequences of experts $D^* = \left\langle d^e{}_{ij} \right\rangle_{n\times n} = \left\langle T_{ij}^e, I_{ij}^e, F_{ij}^e \right\rangle_{n\times n}$, $\left(1 \le e \le m\right)$, where $d^e{}_{ij} = \left\{\left\langle T_{ij}^1, I_{ij}^1, F_{ij}^1 \right\rangle, \left\langle T_{ij}^2, I_{ij}^2, F_{ij}^2 \right\rangle, ..., \left\langle T_{ij}^m, I_{ij}^m, F_{ij}^m \right\rangle\right\}$ represent sequences which describe the relative importance of criterion i in relation to criterion j.

Using the expression (3), an aggregation of values is made at each position of matrix D^*

$$\overline{d}_{ij}=\sum_{e=1}^{m}\left(\varpi_e\cdot d_{ij}^{e}\right)=\left(1-\prod_{e=1}^{m}\left(1-T_{ij}^{e}\right)^{\varpi_e},\prod_{e=1}^{m}\left(I_{ij}^{e}\right)^{\varpi_e},\prod_{e=1}^{m}\left(F_{ij}^{e}\right)^{\varpi_e}\right) \tag{3}$$

where $\overline{d}_{ij}=\left\langle\overline{T}_{ij},\overline{I}_{ij},\overline{F}_{ij}\right\rangle$ represents aggregated SVNN.

That is how we obtain an aggregated single valued neutrosophic matrix of the average response of the experts (4)

$$\overline{D}=\begin{bmatrix}0 & \left\langle\overline{T}_{12},\overline{I}_{12},\overline{F}_{12}\right\rangle & \cdots & \left\langle\overline{T}_{1n},\overline{I}_{1n},\overline{F}_{1n}\right\rangle\\ \left\langle\overline{T}_{21},\overline{I}_{21},\overline{F}_{21}\right\rangle & 0 & \cdots & \left\langle\overline{T}_{2n},\overline{I}_{2n},\overline{F}_{2n}\right\rangle\\ \vdots & \vdots & \ddots & \vdots\\ \left\langle\overline{T}_{n1},\overline{I}_{n1},\overline{F}_{n1}\right\rangle & \left\langle\overline{T}_{n2},\overline{I}_{n2},\overline{F}_{n2}\right\rangle & \cdots & 0\end{bmatrix} \tag{4}$$

Matrix $\overline{D}$ shows the initial effects that factor *j* causes, as well as the initial effects that factor *j* receives from the other factors. The sum of each *i*-th row of matrix $\overline{D}$ represents the total direct effects that factor *i* handed over to the other factors, and the sum of each *i j*--th column of matrix $\overline{D}$ represents the total direct effects that factor *j* receives from the other factors.

Step 4: Determine the SVN total relation matrix. Using expression (5) we calculate a single valued neutrosophic total relation matrix $T=\left\langle t_{ij}\right\rangle_{n\times n}=\left\langle T_{ij}(t),I_{ij}(t),F_{ij}(t)\right\rangle_{n\times n}$. Element $t_{ij}=\left\langle T_{ij}(t),I_{ij}(t),F_{ij}(t)\right\rangle$ represents the direct effect of factor *i* on factor j, while matrix T reflects the overall relationship between each pair of factors.

Since each single valued neutrosophic number consists of three sequences $T_{ij}(t)$, $I_{ij}(t)$ and $F_{ij}(t)$ then the SVN matrix can be divided into three submatrices, i.e. $\overline{D}=\left\langle\overline{T},\overline{I},\overline{F}\right\rangle_{n\times n}$, where, $\overline{T}=\left[\overline{T}_{ij}\right]_{n\times n}$, $\overline{I}=\left[\overline{I}_{ij}\right]_{n\times n}$ and $\overline{F}=\left[\overline{F}_{ij}\right]_{n\times n}$. Furthermore, $\lim_{m\to\infty}\left(\overline{T}\right)^{m}=O$, $\lim_{m\to\infty}\left(\overline{I}\right)^{m}=O$ and $\lim_{m\to\infty}\left(\overline{F}\right)^{m}=O$, where 0 represents zero matrix. Based on the defined settings, we obtain the SVN matrix of total T effects by calculating the following elements

$$\left.\begin{aligned}T(t)&=\lim_{m\to\infty}\left(I+\overline{T}+\overline{T}^{2}+\ldots+\overline{T}^{m}\right)=\left(I-\overline{T}\right)^{-1}=\left[T_{ij}(t)\right]_{n\times n}\\ I(t)&=\lim_{m\to\infty}\left(I+\overline{I}+\overline{I}^{2}+\ldots+\overline{I}^{m}\right)=\left(I-\overline{I}\right)^{-1}=\left[I_{ij}(t)\right]_{n\times n}\\ &\textit{and}\\ F(t)&=\lim_{m\to\infty}\left(I+\overline{F}+\overline{F}^{2}+\ldots+\overline{F}^{m}\right)=\left(I-\overline{F}\right)^{-1}=\left[F_{ij}(t)\right]_{n\times n}\end{aligned}\right\} \tag{5}$$

Sub-matrices $T(t)$, $I(t)$ and $F(t)$ together represent a SVN matrix of total impact $T=\left\langle T(t),I(t),F(t)\right\rangle_{n\times n}$. Based on expression (5) the SVN matrix of total impacts is obtained

$$T=\begin{bmatrix} \langle T_{11}(t),I_{11}(t),F_{11}(t)\rangle & \langle T_{12}(t),I_{12}(t),F_{12}(t)\rangle & \cdots & \langle T_{1n}(t),I_{1n}(t),F_{1n}(t)\rangle \\ \langle T_{21}(t),I_{21}(t),F_{21}(t)\rangle & \langle T_{22}(t),I_{22}(t),F_{22}(t)\rangle & \cdots & \langle T_{2n}(t),I_{2n}(t),F_{2n}(t)\rangle \\ \vdots & \vdots & \ddots & \vdots \\ \langle T_{n1}(t),I_{n1}(t),F_{n1}(t)\rangle & \langle T_{n2}(t),I_{n2}(t),F_{n2}(t)\rangle & \cdots & \langle T_{nn}(t),I_{nn}(t),F_{nn}(t)\rangle \end{bmatrix} \quad (6)$$

where $t_{ij}=\langle T_{ij}(t),I_{ij}(t),F_{ij}(t)\rangle$ is a single valued neutrosophic number which expresses indirect effects of factors i on factor j. Then matrix T reflects the interdependence of each pair of factors.

Step 5: Calculating the sum of the rows and columns of the total impact T matrix. In the total impact T matrix the sum of rows and that of columns is represented by vectors R and C of *n×1*:

$$R_i=\left[\sum_{j=1}^{n}t_{ij}\right]_{n\times 1}=\left[\sum_{j=1}^{n}\langle T_{ij}(t),I_{ij}(t),F_{ij}(t)\rangle\right]_{n\times 1} \quad (7)$$

$$C_i=\left[\sum_{i=1}^{n}t_{ij}\right]_{1\times n}=\left[\sum_{i=1}^{n}\langle T_{ij}(t),I_{ij}(t),F_{ij}(t)\rangle\right]_{1\times n} \quad (8)$$

Step 6: Determination of the weighting coefficients of the criteria. The weighting coefficients of the criteria are determined using the expression

$$W_j=\sqrt{\left(\begin{matrix}2-\sqrt{\left\{\left(1-T(R_i)\right)^2+\left(I(R_i)\right)^2+\left(F(R_i)\right)^2\right\}/3}\\ -\sqrt{\left\{\left(1-T(C_i)\right)^2+\left(I(C_i)\right)^2+\left(F(C_i)\right)^2\right\}/3}\end{matrix}\right)^2}+\sqrt{\left(\begin{matrix}\sqrt{\left\{\left(1-T(R_i)\right)^2+\left(I(R_i)\right)^2+\left(F(R_i)\right)^2\right\}/3}\\ +\sqrt{\left\{\left(1-T(C_i)\right)^2+\left(I(C_i)\right)^2+\left(F(C_i)\right)^2\right\}/3}\end{matrix}\right)^2} \quad (9)$$

Step 7: Forming the initial decision matrix (N). As in DEMATEL method, the evaluation of alternatives by the criteria is being done by *m* experts $\{E_1,E_2,...,E_m\}$ with assigned weighting coefficients $\{\varpi_1,\varpi_2,...,\varpi_m\}$, $\sum_{e=1}^{m}\varpi_e=1$. In order to make a final ranking of alternatives $a_i\in A$ ($i=1,2,..,b$), each expert E_e ($e=1,2,...,m$) evaluates alternatives by a defined set of criteria $C=\{c_1,c_2,...c_n\}$. In that way, correspondent initial decision matrix $N^{(e)}=\left[\eta_{ij}^{(e)}\right]_{b\times n}$ is being constructed for each expert where elements of matrix $N^{(e)}$ ($\eta_{ij}^{(e)}$) represent SVN numbers from a predefined neutrosophic linguistic scale. Final aggregated decision matrix N is obtained by centering matrix elements $\eta_{ij}^{(e)}=\langle T_{\eta ij}^{(e)},I_{\eta ij}^{(e)},F_{\eta ij}^{(e)}\rangle$ of matrix $N^{(e)}$. That is how we obtain matrix $N=\left[\eta_{ij}\right]_{b\times n}$, where elements $\eta_{ij}=\langle T_{\eta ij},I_{\eta ij},F_{\eta ij}\rangle$ are obtained by applying the SWNSWAA operator, the expression (10)

$$\eta_{ij} = SVNSWAA(\eta_{ij}^{(1)}, \eta_{ij}^{(2)}, .., \eta_{ij}^{(m)}) = \sum_{b=1}^{m} \varpi_e \eta_{ij}^{(1)} = \\ = \left\langle 1 - \prod_{b=1}^{m} \left(1 - T_{\eta ij}^{(e)}\right)^{\varpi_e}, \prod_{b=1}^{m} \left(I_{\eta ij}^{(e)}\right)^{\varpi_e}, \prod_{b=1}^{m} \left(F_{\eta ij}^{(e)}\right)^{\varpi_e} \right\rangle \tag{10}$$

where ϖ_e is weighting coefficient, $0 \le \varpi_e \le 1$, $(e = 1, 2, ..., m)$, $\sum_{e=1}^{m} \varpi_e = 1$.

Step 8: Calculation of the elements of the difficult matrix (D). The elements of difficult matrix $D = \left[d_{ij} \right]_{b \times n} = \left[\left\langle T_{dij}, I_{dij}, F_{dij} \right\rangle \right]_{b \times n}$ are obtained by applying the expression (11)

$$d_{ij} = \left\langle T_{dij}, I_{dij}, F_{dij} \right\rangle = w_j \cdot \eta_{ij} = \left\langle 1 - \left(1 - T_{\eta ij}\right)^{w_j}, {I_{\eta ij}}^{w_j}, {F_{\eta ij}}^{w_j} \right\rangle \tag{11}$$

Step 9: Ranking alternatives. On the basis of the value of criterion functions Q_i ($i = 1, 2, ..., b$) ranking of alternatives is carried out. The criteria functions are obtained by applying expression (12),

$$Q_i = \sum_{j=1}^{n} d_j, \quad i = 1, 2, ..., b; \; j = 1, 2, ..., n. \tag{12}$$

4. NUMERICAL EXAMPLE

The SVNN-DEMATEL VKO model for selecting providers was tested on a hypothetical example of the selection of five providers of transport services. As a result of the use of the model, the weighting coefficients of the evaluation criteria were determined and the ranking of the transport providers was performed. Four experts in the field of transport participated in the testing of the model; they got weighting coefficients assigned by using the expression (2) E_1=0.2864, E_2=0.2741, E_3=0.2170 and E_4=0.1673. Experts evaluated the criteria using a linguistic scale: Very important – VI (0.90,0.10,0.10); Important – I (0.75,0.25,0.20); Medium – M (0.50,0.50,0.50); Unimportant – UI (0.35,0.75,0.80); Very unimportant – VU (0.10,0.90,0.90). Five criteria were used to evaluate the provider: C_1 – *Reliability*, C_2 – *Business excellence*, C_3 – *Total cost*, C_4 – *Customer service*, C_5 – *Green image*. Expert evaluations of the criteria are shown in Table 1.

Table 1. Expert analysis of the criteria

Criteria	C_1	C_2	C_3	C_4	C_5
C_1	0	VI;VI;VI;I	I;M;M;I	VI;VI;IVI	I;I;M;UI
C_2	I;M;M;I	0	M;M;VI;VI	M;M;M;M	VI;I;I;VI
C_3	M;M;M;M	M;M;I;I	0	M;I;M;M	VI;VI;VI;VI
C_4	I;I;IVI	M;M;M;M	M;M;M;M	0	M;M;M;M
C_5	M;VU;VU;UI	I;I;I;I	M;M;M;M	I;M;M;I	0

By summing up the elements of the total relation matrix (6) by rows, equation (7), and by columns, equation (8), the values of the total direct and indirect effects of criterion *j* on the other criteria and the other criteria on criterion *j* are obtained.

These values together with the threshold value (α) of the total relation matrix are used for defining the cause-and-effect relationship diagram. The cause and effect relationship (CER) diagram (Figure 1) is formed to visualize the complicated causal relationship of criteria in a visible structural model.

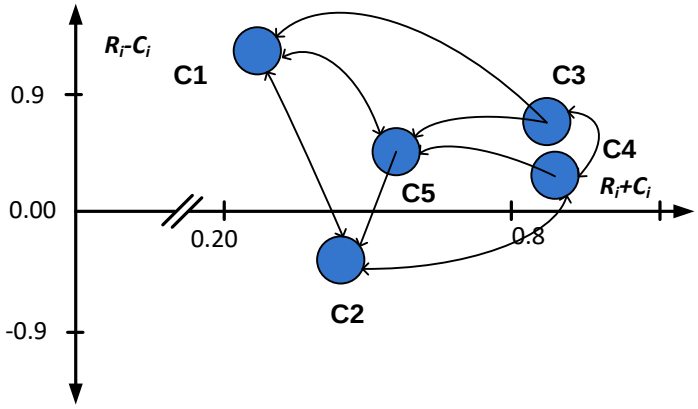

Figure 1. CERD diagram

The elements in matrix T with a value higher than the threshold value α will be identified and mapped on the diagram (Figure 1) where the x-axis denotes (R_i+C_i), and y-axis denotes (R_i-C_i). These values will be used for demonstrating the relationship between two factors. In the course of the demonstration, the arrow denoting the cause-effect membership is directed from the element with a value lower than α towards the element characterized by a higher value than α.

Using the expression (9), we obtain the weight coefficients of the criteria: C_1 (0.828,0.156,0.145), C_2 (0.606,0.381,0.364), C_3 (0.873,0.129,0.147), C_4 (0.641,0.372,0.329) and C_5 (0.709,0.307,0.318).

Expert evaluation of providers by the criteria (Table 2) was carried out using a linguistic scale: Extremely good/high – EG/EH (1,0,0); Very very good/high – VVG/VVH (0.9,0.1,0.1); Very good/high – VG/VH (0.8,0.15,0.2); Good/high – G/H (0.7,0.25,0.3); Medium good/high – MG/MH (0.6,0.35,0.4); Medium /fair – M/F (0.5,0.5,0.5); Medium bad/low – MB/ML (0.4,0.65,0.6); Bad/low – B/L (0.3,0.75,0.7); Very bad/low – VB/VL (0.2,0.85,0.8).

Table 2. Expert evaluation of providers according to the evaluation criteria

Alternative/ criteria	C_1	C_2	C_3	C_4	C_5
A1	VG;MG;VG;G	G;G;MG;G	MG;MG;M;M	G;M;MG;M	M;MH;VH;M
A2	G;VG;MG;MG	VG;MG;M;MG	VG;G;VG;VG	VG;VG;M;G	VH;M;H;H
A3	M;GMG;M	M;VG;G;G	M;G;MG;MG	MG;MG;MG;MG	H;H;M;MH
A4	G;MG;G;MG	MG;M;VG;M	G;MG;G;MG	M;MB;MG;VG	M;M;MH;H
A5	G;G;MG;VG	G;G;MG;VG	MG;G;VG;G	MG;G;VG;G	H;VH;VH;VH

Applying expressions (10) - (12) we get the final rank of the provider: A1 (0.622,0.330,0.374)> A2 (0.571,0.384,0.425)> A3> (0.504,0.457,0.497)>A4 (0.499,0.457,0.497)> A5(0.344,0.643,0.637). The ranking of providers was based on the value of score functions of that time $S(A_i)$ [15].

5. CONCLUSION

In this paper, a new SVNN-DEMATEL multicriteria model of the selection of the transport service provider is presented. This model uses a new neutrosophic number based approach in dealing with uncertainties. Since unambiguous and precise determination of the relative importance of the criteria is not necessary, this model uses, in the process of evaluation, neutrophic linguistic expressions. Therefore, the areas of possible application of the model are numerous: from logistical problems, problems of industrial management, environmental management, education, and health to various other fields of expertise. Also, the model is open for upgrading and expanding by implementing the results of various techniques of group or expert thinking.

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