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Developing a Vendor Selection Model for Telecommunication Systems based on Fuzzy MADM approach

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Abstract

Today organizational environment has been complicated and in such environment importance of organizational communication are greater. One of strategies to better communication is telecommunication systems in the organization. Telecommunications systems have important role in each organization. Vendor selection of a telecommunications system is a multi-attribute decision making problem. Decision making in real world face with imprecise data and furthermore, because such decisions usually are based on the intellectual judgments of managers, to improve decision making must use fuzzy logic. In this paper, we used literature review and experts opinions for determining the model attributes and then developed a fuzzy TOPSIS model with combined weighs basis final weighs. In this model all numbers are fuzzy and triangular typically. A case study done in Qazvin Islamic Azad University to apply the developed model. Result of this decision mentioned that best systems are purchased.

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INTRODUCTION

Today so much time spent in organizations for decision making such as purchase, therefore selecting supplier, make organizations to rethink for purchase and appraisal strategies [12]. Considering important of this subject, many studies such as [1-13, 16, 19, 20, 24, 29, 28]. Today communicating industry are changing fast and for surviving in competitive market it is requisite that companies provide new products for this increasing customers, and need to proper suitable technologies [23]. Telecommunication systems have between 5 to 10 years old or more and they can affect strategic position of organization [23]. Selection process of an proper option are done considering so many parameters such as organizational needs, risks, advantage, goals and limited resources [27]. Vendor selection in telecommunication systems is also like this, it is important for organization and can comprise many attributes such as technical requirements, services and cost characteristics [21]. Furthermore, because of vagueness and low accuracy in human thinking, selection process is often based non proper information and human judgments [27]. Diagnosis of best option for decision makers without a systematic framework about multi attribute problems is very difficult. Because items that affect in these problems are basically defined on basis of mind perceptions and feeling about any attribute, FMCDM can help in better appraisal of options and selecting best options [27]. Therefore in this study we are developing a fuzzy TOPSIS model with composite weighs for telecommunication system vendors. For this at first we identify attribute. Then we determine weights of attributes from judgments of indexes matrix. And this matrix with triangular fuzzy statement then combines those onetime with damped weight method and another time with fuzzy weight finding method. In last stage composite the two weights from average fuzzy method and final weight of attributes

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that are fuzzy are obtained. Then we make decision matrix. In this matrix in addition to weighs, inner statements of matrix are also fuzzy and triangular. Often that with use of TOPSIS method we compute ideal and best option. For testing of model a case study in QIAU has done. This article has organized in following sections: section2: literature review, section 3: identification of attributes, section4: developing fuzzy TOPSIS model and its application in selecting vendors of telecommunication system, final section: conclusion and suggestion for future studies.

2- Literature review

2-1-Vendor Selection methods: So many studies were done on vendors' selection method. Common results of this studies show multi objective nature of supplier selection decisions [6, 11, 19, 16]. Weber et al. [28] analyzed quantitative approaches of this problem. Base on this study linear weighing model models, mathematical programming models and statistic approaches had been used more. Fuzzy AHP approach also has been used [15, 30]. Weber and Kernet [29] have presented a multi objective programming approach for helping purchase managers in vendor selection decision. Ghodyspourand and O'Brien [13] used an AHP and linear programming in selection of best supplier. Boer et al. [6] investigate decision methods in supplier selection process literature. They show that proper methods in operation research like DEA, Total Cost approaches, Linear Programming, Linear Weighting models, statistic models, artificial intelligence models in purchase literature have been used. Karpak et al. [16] presented an Interactive goal programming model for solving a purchase problem. Cebi and Bayraktar [8] organized a supplier selection problem with applying an integrated lexicography goal programming. In literature also have been used cost finding approach based on ABC. For vendor selection have been used quantitative approaches like TCO, AHP, LP, Statistical methods [5]. Bayazit [4] also has used ANP for modeling and solving vendor selection problem. Some of researchers suggested the use of the analytic hierarchy process (AHP) approach for vendor selection problems [19, 23]. They mentioned that AHP has been used because of its inherent utility in Appling in quantitative and qualitative attributes in Vendor Selection Problems. Junyan et al. [14] modeled the vendor selection problem in supply chain with fuzzy chance constrained programming. They suggested a genetic algorithm based on fuzzy simulation for solving their model. Montazer and et al. [18] studied on a vendor selection method using fuzzy Electre III. They tested their model in Iran petro chemistry industry. Kumar et al. [17] in their study presented a fuzzy programming model with three objectives, maximizing costs and maximizing quality and lead-time in supply chain. Shyur and Shih [21] present a multi attribute decision making model for strategic selection of vendors. They used TOPSIS, ANP and NGT in their model. Wadhwa and Ravindran [25] in their study categorize vendor selection methods to three categories consist of pubic models, multi attribute models and discounted models. They suggest a multi objective model with objective of quality, delivery time and production capacity of vendors.

2-2-Attributes literature: These studies almost show that many organizations spend considerable time on supplier selection. Elram [10] investigated vender selection problem using case studies of organization engaged in purchaser-supplier relations. In this study they present some parameter in addition to quality, cost, and on time delivery and that should be concerned in supplier selection. They divided these parameters into four categories: financial, organization, culture and strategy, technology and others. Weber et al. [28] investigate 75 articles that were published from 1966 to 1997 that contained vendor selection attributes in production and retail aspect. They showed that quality, delivery and net price are important. In this study, production facilities, geographic position, financial state and mean capacity were noticed. Nydick and Hill [19] suggested four attributed, quality, price, delivery and service. Another study by Verma and Pullman [24] between 139 managers was done. They looking for question that how does manager tradeoff between quality, cost, on time delivery, delivery time and other attributes in supplier selection time. They show that in managers perception, quality are most important and after that on time delivery and cost. Park and Krishnan [20] investigate supplier selection attribute between 87 small enterprise manager and accepted 15 attribute of Elram [10]. Karpak et al. [16] remarked cost, quality, and confidence of deliver as supplier selection attributes. Handfiled and et al. [13] concentrate on environmental problem in supplier appraisal. Bhutta and Huq [5] used four attribute production cost, quality, technology and service for supplier appraisal. Dikson identify 32 different attribute for vendor selection: quality, delivery, work record, guaranty, price, technical capital and financial position of vendor that mentioned in [23]. Arbel and Seidmann studies [3] and some of other researchers identify some attributes with financial, technical and operational aspects that are applying in communication system selection that are in [23, 31].

3- Identification of attributes

After investigating literature about purchase attributes of a communicating system, interview and consulting with experts in this field, 20 attributes by specialists derived. For increasing research credibility and comprehension and make it operational, we used experts in communications organization and this experts in universities. We design a questionnaire with five degree spectrum and applied to evaluating importance of attributes. Considering that research compass is universities in Qazvin province because there are 15 universities in this state, we send a questionnaire to all of them. But because research constraints such as: bureaucracy, cost and time, only five questionnaires returned back in within three month. For appraisal of reliability mentioned questionnaire Cronbach's alpha was

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used and this coefficient by statistical specialists has been accepted (α=0.7186). Questionnaire validity questionnaire has been approved through Content Validity Method by specialist. From 20 attributes, 14 attributes selected as final attributes. This extraction performed by average points that experts assigned to each attributes so that those attributes finalized that gained points higher than 3. Final attributes are following in Table 2.

Table1: Score average of attributes

Attribute	Score Average	Attribute	Score Average
Purchasing costs	4.25	Ease of Operation	4.75
Cost of Network Management System	1.75	Defect detection capabilities.	4.45
Maintenance costs	3.75	Capabilities of performance assessment	2.05
System capacity	3.9	System security features	4.35
Ability to upgrade software and hardware	1.5	Experience in Related Products	1.5
Reliability / system availability	4.25	Lead-time	3.5
Applicable to other systems	4.35	Problem-solving capabilities.	2.45
Compliance with standards	2.15	After Sales Service	4.5
Future technological development	1.95	Specialty of Supplier	3.5
The physical size of the machine	3.65	Seller's reputation	3.25

4- Fuzzy TOPSIS with combined weights for VSP

In this section we present the methodology for VSP based on TOPSIS with combined weights. In present model all of parameters are fuzzy and triangular typically. For appraisal of attributes to each other and alternatives to each attributes we use linguistic variables. Development steps in this model as below:

Table2: Final attributes for selecting the telecommunication system

Purchasing costs	Defect detection capabilities.
Maintenance costs	Flexibility in accountability
System capacity	System security features
Reliability / system availability	Lead-time
Applicable to other systems	After Sales Service
The physical size of the machine	Specialty of Supplier
Ease of Operation	Seller's reputation

4-1-Step 1: creation of decision matrix

Assume that we have m alternatives and n attributes. Numbers in matrix are linguistic fuzzy parameters that are gained from Table 3 [26]:

$$\tilde{D} = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & & C_n \end{array} \\ \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{11} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix} \end{array}, i = 1,2,\ldots,m; \quad j = 1,2,\ldots,n \quad (1)$$

Table3: fuzzy linguistic variables

FTN1	Very poor\Very low	0.00001	0.00001	1
FTN2	Poor\Low	0.00001	1	3
FTN3	Average poor\Average Low	1	3	5
FTN4	Medium\Fair	3	5	7
FTN5	Good average\High average	5	7	9
FTN6	Good\High	7	9	9
FTN7	Very good\Very high	9	9	10

4-2- Step2: Normalization of decision making matrix

For calculation of $\tilde{r}_{ij}$ for positive attributes we use equation 2 and for negative attribute equation3. So normal matrix $\tilde{R}$ is as below [26]:

$$+\tilde{r}_{ij} = \frac{\tilde{x}_{ij}}{(C^*{}_j, C^*{}_j, C^*{}_j)}, C_j^* = \max C_{ij}, \quad \forall i, i = 1,2,\ldots,m \quad (2)$$

$$-\tilde{r}_{ij} = \frac{(a^-{}_j, a^-{}_j, a^-{}_j)}{\tilde{x}_{ij}}, \quad a_j^- = \min a_{ij}, \quad \forall i, i = 1,2,\ldots,m \quad (3)$$

$$\tilde{R} = \left[\tilde{r}_{ij}\right]_{\max}, \quad i = 1,2,\ldots,m; \quad j = 1,2,\ldots,n \quad (4)$$

4-3- Step 3: define attributes combined weights

Since weight of every attribute has important role in selection of best options, define a weight which based on information, is near the fact, and are important. So for this reason weight of attribute is result of composition of some weight. For achieving final weight these steps have been done:

4-3-1- Define intellectual judgment of every attribute (λ): Considering importance of intellectual judgment of organization manager in decision making [1] this parameter modified with symbol λ, as a vector and in span of [0,1]. As the manager gives every attribute an exact number like below vector:

$$\lambda = [\lambda_1, \lambda_2, \ldots, \lambda_n] \quad (5)$$

4-3-2-Calculation of fuzzy weights based on comparison of attributes: In this step we form fuzzy judgment matrix [26]. This comparison matrix show attribute to each other and assign through verbal parameters that are in table 4. First we form fuzzy judgment matrix:

$$\tilde{C} = \begin{bmatrix} \tilde{1} & \tilde{C}_{12} & \cdots & \tilde{C}_{1n} \\ \tilde{C}_{21} & \tilde{1} & \cdots & \tilde{C}_{2n} \\ \cdots & \cdots & \tilde{1} & \cdots \\ \tilde{C}_{n1} & \tilde{C}_{n2} & \cdots & \tilde{1} \end{bmatrix} = \begin{bmatrix} \tilde{1} & \tilde{C}_{12} & \cdots & \tilde{C}_{1n} \\ \tilde{C}_{21} & \tilde{1} & \cdots & \tilde{C}_{2n} \\ \cdots & \cdots & \tilde{1} & \cdots \\ \tilde{C}_{1n}^{-1} & \tilde{C}^{-1}_{12\ 2n} & \cdots & \tilde{1} \end{bmatrix} \quad (6)$$

Where:

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$$\tilde{C}_{ij} = \begin{cases} \tilde{1},\tilde{3},\tilde{5},\tilde{7},\tilde{9}, & \text{The relative importance of criterion i over criterion j is greater} \\ 1, \quad i=j & \\ \tilde{1}^{-1},\tilde{3}^{-1},\tilde{5}^{-1},\tilde{7}^{-1},\tilde{9}^{-1}, & \text{The relative importance of criterion i over criterion j is less} \end{cases} \quad (7)$$

Table 4: Membership functions of Linguistic scales

Fuzyy number	Symbol used	Membership function
$\tilde{9}$	F9	(7,9,9)
$\tilde{7}$	F7	(5,7,9)
$\tilde{5}$	F5	(3,5,7)
$\tilde{3}$	F3	(1,3,5)
$\tilde{1}$	F1	(1,1,3)
$\tilde{1}^{-1}$	FF1	(.33,1,1)
$\tilde{3}^{-1}$	FF3	(0.2,0.33,1)
$\tilde{5}^{-1}$	FF5	(0.14,0.2,0.33)
$\tilde{7}^{-1}$	FF7	(0.11,0.14,0.2)
$\tilde{9}^{-1}$	FF9	(0.11,0.11,0.14)

In this step fuzzy weight of every attribute are calculated by Bokley formula [7, 26] as below:

$$\tilde{r}_i = \left[\tilde{C}_{i1} \otimes \tilde{C}_{i2} \otimes \cdots \otimes \tilde{C}_{in}\right]^{\frac{1}{n}} \qquad \forall i = 1,2,\ldots,n \qquad (8)$$

$$\tilde{W}_i = \frac{\tilde{r}_i}{\tilde{r}_1 \oplus \cdots \oplus \tilde{r}_n} \qquad (9)$$

Where C_{ij} are fuzzy number of comparison of attribute i to attribute j, and r_i is average of these fuzzy compared numbers and $\tilde{W}_i$ are fuzzy weight of attribute i.

4-3-3-Define approximate of weights ($\tilde{S}_i$) by fuzzy weight finding: In this step we calculate composition of weights troth fuzzy weight finding method. This method is a good approximation of specified quantities vector. In this step we use following equation [2]:

$$\tilde{S}_i = \frac{\sum_{i=1}^{n} \tilde{C}_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{n} \tilde{C}_{ij}} \qquad \forall i = 1,2,\ldots,n \qquad (9)$$

4-3-4-define damped weight of calculation weight ($W_{ave\,i}$): In this step calculated weights based on intellectual judgment of manageress and approximation weights by fuzzy weight finding are combined and modified.

$$\tilde{\mathrm{W}}'_{\mathrm{i}} = \frac{\lambda_i \tilde{S}_i}{\sum_{i=1}^{n} \lambda_i \tilde{S}_i} \qquad \forall i = 1,2,\ldots,n \qquad (10)$$

4-3-5- calculation attributes final weights: Considering statistical method have more applications but we use fuzzy statistical average to calculate final weighted by following equation:

$$\tilde{\mathrm{W}}_{ave\,i} = \frac{\tilde{\mathrm{w}}\mathrm{i} + \tilde{\mathrm{w}}'\mathrm{i}}{2} \qquad \forall i = 1,2,\ldots,n \qquad (11)$$

4-4- Step 4: Calculating weighted fuzzy matrix

In this step attribute` final fuzzy weight vector or W_{ave} with fuzzy multiply in numbers $\tilde{r}_{ij}$ of $\tilde{V}$ matrix will calculate as:

$$\tilde{V} = \left[\tilde{v}_{ij}\right]_{\max}, \qquad i = 1,2,\ldots,m; \qquad j = 1,2,\ldots,n$$
$$\tilde{v}_{ij} = \tilde{r}_{ij} \otimes \tilde{w}_j \qquad (12)$$

4-5- Step5: Defining positive & negative ideal points

From base of fuzzy TOPSIS method are based on farness and nearness of an option to ideal positive and negative states, for calculation of these ideal points we do as below:

From where

$$V_{ij} = \left(V_{ij1}, V_{ij2}, V_{ij3}\right) (13)$$

We define v_j^+ and v_j^- as following:

$$V_j^+ = \max\left(V_{ij3}\right) \qquad \forall i, \qquad j=1,2,\ldots,m \ (14)$$

$$V_j^- = \min\left(V_{ij3}\right) \qquad \forall i, \qquad j=1,2,\ldots,m \ (15)$$

And for calculating the $\tilde{v}_j^*$ and the $\tilde{v}_j^-$ we have:

$$\tilde{V}_j^* = \left(V_j^+, V_j^+, V_j^+\right) (16)$$

$$\tilde{V}_j^- = \left(V_j^-, V_j^-, V_j^-\right) (17)$$

And finally for calculating positive and negative points we have:

$$A^* = \left(\tilde{V}^*1, \tilde{V}^*2, \tilde{V}^*3, \ldots, \tilde{V}^*n\right) (18)$$

$$A^- = \left(\tilde{V}^-1, \tilde{V}^-2, \tilde{V}^-3, \ldots, \tilde{V}^-n\right) (19)$$

4-6- Step6: calculation the distance from positive & negative ideal points

We calculate difference between two fuzzy numbers through following formula [26]:

$$d(\tilde{A},\tilde{B}) = \sqrt{\frac{1}{3}\left[(a_1-b_1)^2 + (a_2-b_2)^2 + (a_3-b_3)^2\right]}$$

So distance from every positive & negative ideal point will as below:

$$d_i^+ = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^+, \qquad i=1,2,\ldots,m; \qquad j=1,2,\ldots,n) \ (20)$$

$$d_i^- = \sum_{i=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^-, \qquad i=1,2,\ldots,m; \qquad j=1,2,\ldots,n) \ (22)$$

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4-7- Final step: calculation contiguity coefficient and ranking alternatives

This coefficient is calculated through applying below equation [26]:

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-} \qquad (23)$$

Then we will rank contiguity coefficient up to down respectively after calculation of cc_i that are crisp number.

5- Numerical example

Now we apply the developed TOPSIS model with combined weights for vendor selection of communication systems. For this a case study has been done in Qazvin Islamic Azad University (QIAU) that in this deciding process; manager wants select best system of four vendors. In the next, we select a communication system based on developed model.

Step1: creation of decision matrix: for creating decision matrix, technical manager of QIAU evaluated each presented system by each vendor based on tables 3 & 14 attributes. This matrix is as table5. In this table sigh (+) show positivity of attribute (higher is better) and sigh (-) show negativity of attribute (lower is better). This matrix is on the table 5.

Step2: Normalization of decision making matrix: The information about this step is presented in table6.

Step3: define attributes combined weights:

3-1-Define intellectual judgment of every attribute (λ *)*: For this, a team consists of three telecommunication specialist is created. This team determined weight of each attribute through personal judgment. Result of this section is presented in Table 7.

3-2- Calculation of fuzzy weights based on comparison of attributes: Related information to this calculation is shown in Tables 8, 9 and 10. In this phase we calculated fuzzy weight of each attribute base on Buckley formula [7, 26] in Table 11. Final calculated weights are presented in Table 12.

3-3-Define approximate weights ($\tilde{S}_i$ *) by fuzzy weight finding*: Results of this section are presented in table 13.

3-4-Define damped weight of calculation weight (W_{avei} *)*: Mentioned weights are illustrated in table14.

3-5-Calculation attributes final weights: These weights are shown in table 15.

Step 4: Calculating weighted fuzzy matrix: In this step vector if matrix $\tilde{V}$ are presented in tables 16 and 17.

Step 5: Defining positive & negative ideal points: Results of this section are presented in table18.

Step6: calculation the distance from positive & negative ideal points: Data about this section are showed in table 19. On this base for positive ideals we have:

$d_1^+ = 2.852841018$
$d_2^+ = 2.961724968$
$d_3^+ = 3.026997693$
$d_4^+ = 2.756255869$

And for negative ideals:
$d_1^- = 0.938843$
$d_2^- = 0.701312$
$d_3^- = 0.554906$
$d_4^- = 1.157216$

Final step: calculation contiguity coefficient and ranking alternatives: These coefficients are come in table 21.

After this step, we arrange these coefficients base on up to down. Therefore ranking is following:

A4>A1>A2>A3

Thus, QIAU must select fourth system and purchase it.

Table 5: evaluation matrix based on attributes

	-	-	-	-	-	-	-	+	+	+	+	+	+	+
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14
A1	FTN4	FTN1	FTN3	FTN3	FTN2	FTN7	FTN4	FTN5	FTN7	FTN1	FTN2	FTN5	FTN7	FTN3
A2	FTN5	FTN7	FTN5	FTN2	FTN5	FTN7	FTN1	FTN4	FTN5	FTN3	FTN3	FTN2	FTN6	FTN4
A3	FTN2	FTN5	FTN7	FTN3	FTN4	FTN5	FTN3	FTN3	FTN2	FTN7	FTN4	FTN1	FTN7	FTN5
A4	FTN1	FTN6	FTN4	FTN2	FTN6	FTN3	FTN5	FTN1	FTN4	FTN5	FTN7	FTN7	FTN3	FTN4

Table 7: Subjective judgments of managers

λ1	0.08	λ8	0.023
λ2	0.061	λ9	0.011
λ3	0.077	λ10	0.049
λ4	0.19	λ11	0.045
λ5	0.114	λ12	0.123
λ6	0.079	λ13	0.096
λ7	0.016	λ14	0.034

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Table 6: Normalizing the decision matrix

	C1			C2			C3			C4			C5			C6			C7			C8			C9			C10			C11			C12			C13			C14		
A1	3	5	7	0	0	1	1	3	5	1	3	5	0	1	3	9	9	10	3	5	7	5	7	9	9	9	10	0	0	1	0	1	3	5	7	9	9	9	10	1	3	5
A2	5	7	9	9	9	10	5	7	9	0	1	3	5	7	9	9	9	10	0	0	1	3	5	7	5	7	9	1	3	5	1	3	5	0	1	3	7	9	9	3	5	7
A3	0	1	3	5	7	9	9	9	10	1	3	5	3	5	7	5	7	9	1	3	5	1	3	5	0	1	3	9	9	10	3	5	7	0	0	1	9	9	10	5	7	9
A4	0	0	1	7	9	9	3	5	7	0	1	3	7	9	9	1	3	5	5	7	9	0	0	1	3	5	7	5	7	9	9	9	10	9	9	10	1	3	5	3	5	7
Normalizing	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0	0	9	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	9	9	9

Table 8: Paired comparisons of attributes based on fuzzy numbers

	C1			C2			C3			C4			C5			C6			C7		
C1	1	1	3	3	5	7	1	3	5	7	9	9	1	1	3	5	7	9	1	1	3
C2	0.14	0.2	0.33	1	1	3	3	5	7	1	3	5	7	9	9	1	1	3	5	7	9
C3	0.2	0.33	1	0.14	0.2	0.33	1	1	3	3	5	7	1	3	5	7	9	9	1	1	3
C4	0.11	0.11	0.14	0.2	0.33	1	0.14	0.2	0.33	1	1	3	3	5	7	1	3	5	7	9	9
C5	0.33	1	1	0.11	0.11	0.14	0.2	0.33	1	0.14	0.2	0.33	1	1	3	3	5	7	1	3	5
C6	0.11	0.14	0.2	0.33	1	1	0.11	0.11	0.14	0.2	0.33	1	0.14	0.2	0.33	1	1	3	3	5	7
C7	0.33	1	1	0.11	0.14	0.2	0.33	1	1	0.11	0.11	0.14	0.2	0.33	1	0.14	0.2	0.33	1	1	3
C8	0.14	0.2	0.33	0.33	1	1	0.11	0.14	0.2	0.33	1	1	0.11	0.11	0.14	0.2	0.33	1	0.14	0.2	0.33
C9	0.11	0.14	0.2	0.14	0.2	0.33	0.33	1	1	0.11	0.14	0.2	0.33	1	1	0.11	0.11	0.14	0.2	0.33	1
C10	0.14	0.2	0.33	0.11	0.14	0.2	0.14	0.2	0.33	0.33	1	1	0.11	0.14	0.2	0.33	1	1	0.11	0.11	0.14
C11	0.11	0.11	0.14	0.14	0.2	0.33	0.11	0.14	0.2	0.14	0.2	0.33	0.33	1	1	0.11	0.14	0.2	0.33	1	1
C12	0.14	0.2	0.33	0.11	0.11	0.14	0.14	0.2	0.33	0.11	0.14	0.2	0.14	0.2	0.33	0.33	1	1	0.11	0.14	0.2
C13	0.11	0.14	0.2	0.14	0.2	0.33	0.11	0.11	0.14	0.14	0.2	0.33	0.11	0.14	0.2	0.14	0.2	0.33	0.33	1	1
C14	0.14	0.2	0.33	0.11	0.14	0.2	0.14	0.2	0.33	0.11	0.11	0.14	0.14	0.2	0.33	0.11	0.14	0.2	0.14	0.2	0.33

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Table 9: More Table 8

	C8			C9			C10			C11			C12			C13			C14		
C1	3	5	7	5	7	9	3	5	7	7	9	9	3	5	7	5	7	9	3	5	7
C2	1	1	3	3	5	7	5	7	9	3	5	7	7	9	9	3	5	7	5	7	9
C3	5	7	9	1	1	3	3	5	7	5	7	9	3	5	7	7	9	9	3	5	7
C4	1	1	3	5	7	9	1	1	3	3	5	7	5	7	9	3	5	7	7	9	9
C5	7	9	9	1	1	3	5	7	9	1	1	3	3	5	7	5	7	9	3	5	7
C6	1	3	5	7	9	9	1	1	3	5	7	9	1	1	3	3	5	7	5	7	9
C7	3	5	7	1	3	5	7	9	9	1	1	3	5	7	9	1	1	3	3	5	7
C8	1	1	3	3	5	7	1	3	5	7	9	9	1	1	3	5	7	9	1	1	3
C9	0.14	0.2	0.33	1	1	3	3	5	7	1	3	5	7	9	9	1	1	3	5	7	9
C10	0.2	0.33	1	0.14	0.2	0.33	1	1	3	3	5	7	1	3	5	7	9	9	1	1	3
C11	0.11	0.11	0.14	0.2	0.33	1	0.14	0.2	0.33	1	1	3	3	5	7	1	3	5	7	9	9
C12	0.33	1	1	0.11	0.11	0.14	0.2	0.33	1	0.14	0.2	0.33	1	1	3	3	5	7	1	3	5
C13	0.11	0.14	0.2	0.33	1	1	0.11	0.11	0.14	0.2	0.33	1	0.14	0.2	0.33	1	1	3	3	5	7
C14	0.33	1	1	0.11	0.14	0.2	0.33	1	1	0.11	0.11	0.14	0.2	0.33	1	0.14	0.2	0.33	1	1	3

Table10: Paired comparisons of attributes based on fuzzy linguistic variables

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14
C1	F1	F5	F3	F9	F1	F7	F1	F5	F7	F5	F9	F5	F7	F5
C2	FF5	F1	F5	F3	F9	F1	F7	F1	F5	F7	F5	F9	F5	F7
C3	FF3	FF5	F1	F5	F3	F9	F1	F7	F1	F5	F7	F5	F9	F5
C4	FF9	FF3	FF5	F1	F5	F3	F9	F1	F7	F1	F5	F7	F5	F9
C5	FF1	FF9	FF3	FF5	F1	F5	F3	F9	F1	F7	F1	F5	F7	F5
C6	FF7	FF1	FF9	FF3	FF5	F1	F5	F3	F9	F1	F7	F1	F5	F7
C7	FF1	FF7	FF1	FF9	FF3	FF5	F1	F5	F3	F9	F1	F7	F1	F5
C8	FF5	FF1	FF7	FF1	FF9	FF3	FF5	F1	F5	F3	F9	F1	F7	F1
C9	FF7	FF5	FF1	FF7	FF1	FF9	FF3	FF5	F1	F5	F3	F9	F1	F7
C10	FF5	FF7	FF5	FF1	FF7	FF1	FF9	FF3	FF5	F1	F5	F3	F9	F1
C11	FF9	FF5	FF7	FF5	FF1	FF7	FF1	FF9	FF3	FF5	F1	F5	F3	F9
C12	FF5	FF9	FF5	FF7	FF5	FF1	FF7	FF1	FF9	FF3	FF5	F1	F5	F3
C13	FF7	FF5	FF9	FF5	FF7	FF5	FF1	FF7	FF1	FF9	FF3	FF5	F1	F5
C14	FF5	FF7	FF5	FF9	FF5	FF7	FF5	FF1	FF7	FF1	FF9	FF3	FF5	F1

Table11: Fuzzy weight of each attribute based on Buckley formula

$\tilde{r}1$=	(0.0878	0.2053	0.4689)
$\tilde{r}2$=	(0.0705	0.1631	0.377)
$\tilde{r}3$=	(0.0561	0.1312	0.3222)
$\tilde{r}4$=	(0.0443	0.0999	0.2437)
$\tilde{r}5$=	(0.0356	0.0854	0.2083)
$\tilde{r}6$=	(0.0281	0.0661	0.1616)
$\tilde{r}7$=	(0.0231	0.0575	0.1381)
$\tilde{r}8$=	(0.0186	0.0457	0.111)
$\tilde{r}9$=	(0.0159	0.0397	0.0915)
$\tilde{r}10$=	(0.0123	0.0308	0.0723)
$\tilde{r}11$=	(0.0105	0.0263	0.0581)
$\tilde{r}12$=	(0.0079	0.0201	0.0458)
$\tilde{r}13$=	(0.0068	0.0161	0.0364)
$\tilde{r}14$=	(0.0055	0.0128	0.0293)

Table12: Final fuzzy weights

$\widetilde{w_1}$=	(0.0612	0.1745	0.5266)
$\widetilde{w_2}$=	(0.0477	0.1326	0.3955)
$\widetilde{w_3}$=	(0.0421	0.1234	0.3984)
$\widetilde{w_4}$ =	(0.0543	0.1806	0.6568)
$\widetilde{w_5}$ =	(0.0336	0.1094	0.3897)
$\widetilde{w_6}$ =	(0.024	0.0744	0.2578)
$\widetilde{w_7}$ =	(0.0132	0.0359	0.0999)
$\widetilde{w_8}$ =	(0.0114	0.0317	0.0939)
$\widetilde{w_9}$ =	(0.0089	0.024	0.0629)
$\widetilde{w_{10}}$=	(0.0094	0.0294	0.0962)
$\widetilde{w_{11}}$=	(0.008	0.0255	0.0791)
$\widetilde{w_{12}}$=	(0.0078	0.03	0.1185)
$\widetilde{w_{13}}$=	(0.006	0.0201	0.0749)
$\widetilde{w_{14}}$=	(0.0032	0.0086	0.0259)

Table 13: approximate weights by fuzzy weight finding

S1=	(0.0693571	0.14033962	0.279)
S2=	(0.0652246	0.13071633	0.2592)
S3=	(0.0582889	0.11734397	0.2355)
S4=	(0.054113	0.10754025	0.2151)
S5=	(0.0444753	0.09150143	0.1914)
S6=	(0.0402994	0.08175785	0.1712)
S7=	(0.0335515	0.06972874	0.1474)
S8=	(0.029419	0.06010546	0.1276)
S9=	(0.028133	0.05838128	0.1193)
S10=	(0.0211106	0.04474829	0.0936)
S11=	(0.0198246	0.04296397	0.0851)
S12=	(0.0099123	0.02532128	0.0594)
S13=	(0.0086263	0.0195874	0.0451)
S14=	(0.0044938	0.00996411	0.0253)

Table14: damped weight of calculation weight

$\tilde{w}'1$ =	(0.0347	0.1436	0.5843)
$\tilde{w}'2$ =	(0.0249	0.102	0.4139)
$\tilde{w}'3$ =	(0.0281	0.1156	0.4746)
$\tilde{w}'4$ =	(0.0643	0.2614	1.0698)
$\tilde{w}'5$ =	(0.0317	0.1335	0.571)
$\tilde{w}'6$ =	(0.0199	0.0826	0.354)
$\tilde{w}'7$ =	(0.0034	0.0143	0.0617)
$\tilde{w}'8$ =	(0.0042	0.0177	0.0768)
$\tilde{w}'9$ =	(0.0019	0.0082	0.0344)
$\tilde{w}'10$ =	(0.0065	0.0281	0.12)
$\tilde{w}'11$ =	(0.0056	0.0247	0.1002)
$\tilde{w}'12$ =	(0.0076	0.0398	0.1911)
$\tilde{w}'13$ =	(0.0052	0.0241	0.1134)
$\tilde{w}'14$ =	(0.001	0.0043	0.0225)

Table15: Final weight of attributes

$\tilde{W}_{ave1}$	=(0.0612	0.1745	0.5266)
$\tilde{W}_{ave2}$	=(0.0477	0.1326	0.3955)
$\tilde{W}_{ave3}$	=(0.0421	0.1234	0.3984)
$\tilde{W}_{ave4}$	=(0.0543	0.1806	0.6568)
$\tilde{W}_{ave5}$	=(0.0336	0.1094	0.3897)
$\tilde{W}_{ave6}$	=(0.024	0.0744	0.2578)
$\tilde{W}_{ave7}$	=(0.0132	0.0359	0.0999)
$\tilde{W}_{ave8}$	=(0.0114	0.0317	0.0939)
$\tilde{W}_{ave9}$	=(0.0089	0.024	0.0629)
$\tilde{W}_{ave10}$	=(0.0094	0.0294	0.0962)
$\tilde{W}_{ave11}$	=(0.008	0.0255	0.0791)
$\tilde{W}_{ave12}$	=(0.0078	0.03	0.1185)
$\tilde{W}_{ave13}$	=(0.006	0.0201	0.0749)
$\tilde{W}_{ave14}$	=(0.0032	0.0086	0.0259)

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Table16: weighted fuzzy matrix

	C1			C2			C3			C4			C5			C6			C7		
A1	8.7E-08	3E-07	1.76E-06	4.771E-07	0.1325743	0.39545214	0.0084	0.0411	0.3984	1E-07	6E-07	7E-06	1E-07	1E-06	0.3897	0.0024	0.0083	0.0286	2E-08	7E-08	3E-07
A2	6.8E-08	2E-07	1.05E-06	4.771E-08	1.473E-07	4.3939E-07	0.0047	0.0176	0.0797	2E-07	2E-06	0.6568	4E-08	2E-07	8E-07	0.0024	0.0083	0.0286	1E-07	0.0359	0.0999
A3	2E-07	2E-06	0.526601	5.301E-08	1.894E-07	7.909E-07	0.0042	0.0137	0.0443	1E-07	6E-07	7E-06	5E-08	2E-07	1E-06	0.0027	0.0106	0.0516	3E-08	1E-07	1E-06
A4	6.1E-07	0.1745	0.526601	5.301E-08	1.473E-07	5.6493E-07	0.006	0.0247	0.1328	2E-07	2E-06	0.6568	4E-08	1E-07	6E-07	0.0048	0.0248	0.2578	1E-08	5E-08	2E-07

Table17: More table 16

	C8			C9			C10			C11			C12			C13			C14		
A1	0.0063	0.0247	0.0939	0.008	0.0216	0.0629	9E-09	3E-08	0.0096	8E-09	0.0026	0.0237	0.0039	0.021	0.1066	0.0054	0.0181	0.0749	0.0004	0.0029	0.0144
A2	0.0038	0.0176	0.0731	0.0045	0.0168	0.0566	0.0009	0.0088	0.0481	0.0008	0.0077	0.0396	8E-09	0.003	0.0355	0.0042	0.0181	0.0674	0.0011	0.0048	0.0202
A3	0.0013	0.0106	0.0522	9E-09	0.0024	0.0189	0.0084	0.0265	0.0962	0.0024	0.0128	0.0554	8E-09	3E-08	0.0118	0.0054	0.0181	0.0749	0.0018	0.0067	0.0259
A4	1E-08	4E-08	0.0104	0.0027	0.012	0.0441	0.0047	0.0206	0.0865	0.0072	0.023	0.0791	0.007	0.027	0.1185	0.0006	0.006	0.0375	0.0011	0.0048	0.0202

Table 18: Positive & negative ideal points for each attribute

	C1			C2			C3			C4			C5			C6			C7		
Positive Ideal	0.5266	0.5266	0.526601	0.3954521	0.3954521	0.39545214	0.3984	0.3984	0.3984	0.6568	0.6568	0.6568	0.3897	0.3897	0.3897	0.2578	0.2578	0.2578	0.0999	0.0999	0.0999
Negative Ideal	6.8E-08	7E-08	6.8E-08	4.771E-08	4.771E-08	4.7707E-08	0.0042	0.0042	0.0042	1E-07	1E-07	1E-07	4E-08	4E-08	4E-08	0.0024	0.0024	0.0024	1E-08	1E-08	1E-08

	C8			C9			C10			C11			C12			C13			C14		
Positive Ideal	0.0939	0.0939	0.0939	0.0629	0.0629	0.0629	0.0962	0.0962	0.0962	0.0791	0.0791	0.0791	0.1185	0.1185	0.1185	0.0749	0.0749	0.0749	0.0259	0.0259	0.0259
Negative Ideal	1E-08	1E-08	1E-08	9E-09	9E-09	9E-09	9E-09	9E-09	9E-09	8E-09	8E-09	8E-09	8E-09	8E-09	8E-09	0.0006	0.0006	0.0006	0.0004	0.0004	0.0004

Table 19: distance from positive ideal point for each attribute

distance from positive	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14
A1	0.526337365	0.274020254	0.305228197	0.656429241	0.318001035	0.244813191	0.099877296	0.064449087	0.039671171	0.09300915	0.071146209	0.087103263	0.051812815	0.020942744
A2	0.526337638	0.395254158	0.36571451	0.5359734	0.389470416	0.244813191	0.068484192	0.069213284	0.04314216	0.079544982	0.065323676	0.106807981	0.052527279	0.019118101
A3	0.42975246	0.395254025	0.377893962	0.656429241	0.389470218	0.237014194	0.099877056	0.075860652	0.056438897	0.06463184	0.060132715	0.114618469	0.051812815	0.017811151
A4	0.365560022	0.395254114	0.348265498	0.5359734	0.389470502	0.198463524	0.099877349	0.090548036	0.046821116	0.068677951	0.052655645	0.083238842	0.06233177	0.019118101

Table 20: distance from negative ideal point for each attribute

distance from negative	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14
A1	9.87133E-07	0.240682594	0.228496947	3.73815E-06	0.224861015	0.015516728	1.86665E-07	0.056164098	0.038668397	0.005548456	0.013780851	0.062756392	0.044134448	0.008228613
A2	5.7803E-07	2.33219E-07	0.044240189	0.378990936	4.33617E-07	0.015516728	0.061273633	0.043425367	0.03418527	0.028211641	0.023264843	0.020585382	0.039906614	0.011710292
A3	0.303881401	4.36605E-07	0.023760862	3.73815E-06	7.35484E-07	0.028760665	5.71407E-07	0.03073573	0.010982215	0.057758173	0.032838176	0.006837561	0.044134448	0.015211307
A4	0.320125857	3.03969E-07	0.075153101	0.378990936	3.03573E-07	0.147941483	1.08898E-07	0.00602316	0.026390331	0.051403615	0.047741604	0.070239265	0.021495609	0.011710292

Table21: contiguity coefficient for each alternative

CC1	0.247605902
CC2	0.191456466
CC3	0.154919301
CC4	0.295700599

CONCLUSION

Problem of telecommunication system Selection are important considering position of communication in organization. In another hand, organization decisions are based on manager judgments and for consideration of that; fuzzy logic are used. For this the attributes was gained from literature review and expert opinions. After that a fuzzy TOPSIS model with combined weights was developed. Because importance of attributes weights and existence of mistake possibility in defining the weights; a combing approach was developed.

In this approach for closing to real weights was used combination of various methods. Combined weights are result of integrating various methods such as intellectual judgment of managers, fuzzy statistical average, modified weights and fuzzy weight finding. For future study it is possible to use other MADM methods like ELECTRE, VIKOR or creation a composite algorithm using various techniques. And can use trapezoid instead triangular fuzzy number or a combination of there. For filtering effective attribute in big and complicate problems, we can use the other methods such as BORDA and linear assigning algorithm. It is possible to use developed model to other problem of decision making or use other methods and combing there for defining the final weights.

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