Requirements Prioritization Using Logarithmic Fuzzy Trapezoidal Approach (LFTA)

Yash Veer Singh, Bijendra Kumar, and Satish Chand

Abstract

Requirement prioritization (RP) is considered as an important phase of SDLC in the process of requirements engineering. Requirement prioritization techniques are very useful for making good decisions to determine the relative priority weights of the requirements as per their importance. The existing techniques are very complex and time consuming in fuzzy environment. FAHP is a very appropriate approach for RP. The FAHP has found its significant applications in today's scenario and majority of the applications in requirement prioritization are derived by using EA and FPA and nonlinear techniques for fuzzy AHP priority derivation. However, FPA-based nonlinear approach is effective one but exhibits several issues of uncertainty and complexity. The performance of such prioritization approaches does not provide the appropriate priority as per the customer expectations, create multiple and conflict priority vectors, may result in different conclusions which are not acceptable to fuzzy pairwise comparison matrix. This research paper helps to overcome the issue of existing approach, proposes an effective and appropriate priority technique for fuzzy AHP called logarithmic fuzzy trapezoidal approach (LFTA) to conclude the priorities vector of requirements engineering. The proposed technique is used to resolve the typical gaps and meets the customer expectations of judgment making in real-life applications This technique is tested on real-life project 'selection rank 1 of college' based on different criteria's.

Keywords

Requirements prioritization • FAHP • LFTA • FPA • Extent analysis

1 Introduction

RP is a key phase of software development life cycle (SDLC) in requirement engineering (RE) process. This phase consists of an identification of every requirement like validation of requirements, requirement elicitation and gathering, analysis, their documentation, and management. RE includes 'RP' that is used to ranking the requirements as per their weights of importance (Sadiq & Jain, 2014; Sipahi & Timor, 2010; Soh, 2010; Sun, 2010). We take an example of a project when it has insufficient resources; hard execution plan, too many high customer hopes, and then customer requirements must be arranged as per their priority beforehand.

Therefore, RP is much significant for choosing the accurate set of requirements and makes many judgments during the final product release. For this reason, several researchers are engaged in the process of developing the correct set of priorities for decision in RP. As per previous research studies like FAHP and FPA, existing techniques dealing with uncertainty and ambiguity, fuzziness in RP, when multiple stakeholders have different opinions of alternatives. Nowadays, we make various selections, like selection of rank 1 college, skilled faculty, buying a DVD-player, new smart phone, food, etc. Regularly, we are not in any case aware of making one. Normally, we do not have more than a one or two decisions to consider, an example, which is the rank 1 college, skilled faculty, best brand based on quality. Indeed, even with a few judgments,

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selections can be so tough to take. Similarly, it is having tens, thousand, and hundreds or even a huge number of choices, judgments become much more typical task in RE. This paper explains the mathematical form to solve the requirement prioritization, difficulty of decision making. The importance of software requirements can be varied according to the problem of selecting decision or decision making. In previous existing methods test on software providers, seller/buyer does not have well organized and method of selection. In this paper, evaluate a case study of college selection using two techniques of RP, which is used to determine the importance of candidate requirements and pairwise comparison technique. Therefore, a pairwise comparison method for RP is used. In this research work, A LFTA is demonstrated to overcome the limitations of FAHP and FPA.

2 Related Work

There are so many conflicts arises when the priority of requirements in the equation of linguistic variables (Sun, 2010). The linguistic variables are those variables that cannot be represented by numerical values. FAHP has found enormous applications in the present time, subsequently fuzzy decisions are easier to evaluate the weights of requirements as compared to crisp decisions (Sadiq & Jain, 2014). It decided the FAHP can find more and better applications in immediate future. The use of FAHP to RP needs scientific methods for deriving the weights produced from pairwise comparison (PWC) matrices with EA and FPA (Veerabathiran & Srinath, 2012) is depend on nonlinear technique (Wang & Chin, 2011). The application of FAHP for evaluating the priorities in the form of weights in the EIS (estimate index system) can be momentarily explained as follows. After that first a hierarchical configuration is designed (Soh, 2010), and then a group of judges is designed and requested for evaluation for the criteria's, attributes, or characteristics. The comparison of arrangement of one criterion over another can be done with the common agreement of all the team/group members, which are in the form of a linguistic valuation (Ho et al., 2010). In this proposed novel approach, linguistic valuation (crisp input sets) decided by a group of judges is transformed to LFTA which is shown in Fig. 3. Then these logarithmic fuzzy trapezoidal numbers (Kahraman & Kaya, 2010; Sipahi and Timor, 2010) are used to figure out the evaluation matrices of judges fully based on the PWC technique.

The matrices of PWC are used to calculate the priorities of multiple criterias and features by using the fuzzy AHP technique. Existing techniques for FAHP weight origin can be categorized into two types of classes, one class is to originate a group of fuzzy priorities, next one is to emerge a group of crisp priority weights derived through a fuzzy PWC matrix. The technologies derived through fuzzy weights emerging from fuzzy PWC state normally consist of the geometric mean approach (Jaskowski et al., 2010; Sun, 2010) and least-squares approaches) (LSM) (Dubois,2011), linear goal programming (LGP) technique, and Lambda–Max techniques (Calabrese et al., 2013). The methods for originating crisp weights derived through PWC matrices comprise the FPP and EA. Since fuzzy weights are not able to compute easily crisp ones, several research ideas describe that enormous usual of FAHP application applies a simple EA method for FAHP weight derivation. EA approach (Celik et al., 2009) represented to be unacceptable and the outcomes generated by EA do not designate the priority weight of judgment criteria. So, it has directed to a significantly large number of mismanagings in the existing research work (Abu-Taha, 2011; Büyüközkan & Berkol, 2011; Bueyuekoezkan & Ruan, 2007; Cebeci & Ruan, 2007; Chan & Kumar, 2007; Chan et al., 2008; Celik et al., 2009; Haghighi et al., 2010; Heo et al., 2010; Kahraman et al., 2006; Kaya & Kahraman, 2010; Kelemenis & Askounis, 2010; Shaw et al., 2012; Sevkli, 2010; Ye, 2010; Yücel & Güneri, 2011). Speciously, its use as a weight priority derivation method should be avoided (Sadiq & Jain, 2015). FPA nonlinear priority method proposed has also found numerous applications in current years. Unfortunately, the methods go out to matter to a number of important weaknesses. Such as, it may produce many identical or uniform dispute priority weights for pairwise comparison matrix, managing with dissimilar outcomes. Such types of non-uniqueness outcomes harm its applications as a priority technique for FAHP. In addition, proposed examination system was found to be more, complete and accurate through the assessment technique, that compared to conventional FAHP and AHP using EA technique. Although (Nagpal et al., 2015; Wang et al., 2016; Zhü, 2014) FAHP has been realistic in many cases, who use FAHP would comprehend the problems connected with this method (Khan et al., 2015). Author employs FAHP on marketing data to decompose the problem into a two-dimensional type (Serhani et al., 2020). Author explains such type of questions (i) selection methods which are generally applied; (ii) problem conservational and selection criteria for supplier management which are well-liked; (iii) selection shortcomings. Decision making using AHP on precipitation data (Govindan et al., 2015; Khazaeni et al., 2012; Vaishnavi et al., 2017) on green product development with multi-criteria group decision-making (MCDM) technique. To present an exact priority method for FAHP, the proposed technique (LFTA) for FAHP weight/priority derivation, which communicates priorities weights for fuzzy pairwise comparison matrix by using originates crisp priorities weights and logarithmic nonlinear programming.

3 Requirements Prioritization Techniques

(a) **FAHP: Fuzzy Analytical Hierarchical Process**

A trapezoidal fuzzy number (TFN) consists of variety of global states. This investigation represents the fuzzy weights which are contained in MCDM demonstrated through linguistic variables expressed in the trapezoidal fuzzy numbers.

A trapezoidal fuzzy number is expressed as $\tilde{F}s = (a, b, c, d)$ and also represented through the following function:

$$\mu_{Fs}(x) = \begin{cases} \frac{x-a}{b-a} & a \le x \le b \\ 1 & b \le x \le c \\ \frac{d-x}{d-c} & c \le x \le d \end{cases} \quad (1)$$

Here, 'b' and 'c' are known intervals in mode $\tilde{F}s$ while 'a' and 'd' are the decision parameters which demonstrates the lower value and upper value in the form of bound (lower and upper) on $\tilde{F}s$. Figure 1 shows the range for the evaluations.

(b) **Fuzzy Preference Approach (FPA)/Extent Analysis (EA) Nonlinear Priority Technique**

It can be represented by the following equation:

Subject to

$$\begin{cases} -E_i + a_{ij}E_j + \beta(b_{ij} - a_{ij})E_j \le 0, \; i = 1, \ldots, n-1; \; j = i+1, \ldots, n, \\ E_i - c_{ij}E_j + \beta(C_{ij} - b_{ij})E_j \le 0, \; i = 1, \ldots, n-1; \; j = i+1, \ldots, n \\ \sum_{i=1}^{n} E_i = 1, \\ E_i \ge 0, \; i - 1, \ldots, n. \end{cases} \quad (2)$$

To understand better, we mentioned an approach represented in above Eq. (2) to the AHP fuzzy priority examination named as FPP or FPA-based nonlinear priority method. After evaluation this approach, we finalized these following research summary:

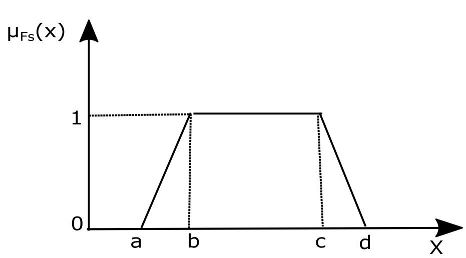


Fig. 1 Membership degree function for fuzzy trapezoidal

1. Membership degree function having negative value denotes no judgment or no sense.
2. Equation number (2) denotes multiple optimal solutions in case of inconsistency among fuzzy judgments.
3. In fuzzy PWC matrix, the value of priority weight vectors for lower and upper triangular elements is same.

4 Proposed LFTA Method

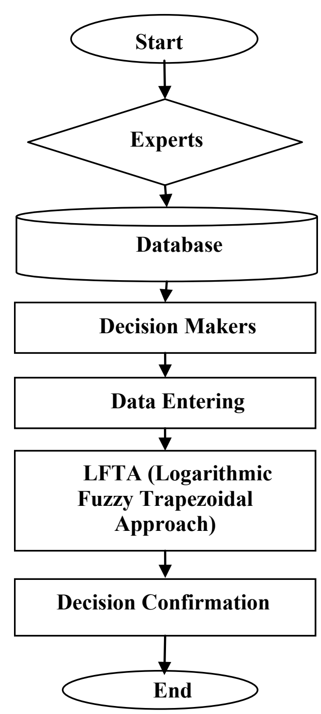
The proposed method solves the limitations of EA in RP with LFTA. The proposed method contains the following steps which is shown in Fig. 2

(i) **Expert Model (Information Gathering)**: This model can be selected by the judges and students to gather all the accurate data regarding the institute like the placement of the student's, infrastructure technical and cultural activity, faculty profile, and research at the superior salary package.

(ii) **Database Model (Storing information in Database)**: The second phase of the LFTA model is used for storage of data, assimilation, and explanations of all information of college, computed by decision makers and students for taking optimal decisions.

(iii) **Decision Makers Model (Taking Optimal Decisions)**: During the admission time, the students choose the rank 1 college that fulfills their academic and placement criteria's for their study and job

Fig. 2 Proposed LFTA model



placements. In this proposed approach, they must be always demanded to select the choice of gear. This research work carried out to solve and exploit their suggestions to concise the LFPP technique.

(iv) Data Inflowing Model (LFTA)
Decision makers play very important role to analyze and pass all the information.

Proposed LFTA Model:

This model solves the above limitations of EA in RP with LFTA shown in Fig. 3. This model provides the following outcomes to overcome the existing limitations.

[1] This model provides always positive value among 0 and 1 for the membership function (β) to eliminate inconsistency in the mid of the fuzzy judgments.
[2] This model provides always unique solutions which is always optimal for fuzzy decisions in the form of weight vectors to maintain consistency.
[3] In this model, the outcomes of upper and lower triangular elements of the PWC matrix are same in the form of priority weights vectors.

$$\overline{\overline{E\underbrace{*^1}_{J}}} = (0.4540, 0.1820, 0.1820, 0.1820), \beta^* = -1.98 \quad (3)$$

$$\overline{\overline{E\underbrace{*^2}_{J}}} = (0.24, 0.25, 0.25, 0.26), \beta^* = -1.98 \quad (4)$$

$$\overline{\overline{E\underbrace{*^3}_{J}}} = (0.2863, 0.2379, 0.2379, 0.2379), \beta^* = -1.98 \quad (5)$$

These dissimilar priority weights vectors certainly create fuzzy AHP (FAHP) decision-making, complex, and more complex. In the further section, we will design a LFTA-based methodology to overcome above mentioned drawbacks.

Let judges give fuzzy judgments instead of exact judgments for fuzzy PWC matrix, so it is concluded that the criterion i is among a_{ij} and d_{ij} as significant as typical j through b_{ij} and c_{ij} most likely. A trapezoidal fuzzy PWC matrix can be demonstrated:

$$J = \begin{bmatrix} (1,1,1,1) & (a_{12},b_{12},c_{12},d_{12}) & (a_{13},b_{13},c_{13},d_{13}) & (a_{14},b_{14},c_{14},d_{14}) \\ (a_{21},b_{21},c_{21},d_{21}) & (1,1,1,1) & (a_{23},b_{23},c_{23},d_{23}) & (a_{24},b_{24},c_{24},d_{24}) \\ \cdots & \cdots & \cdots & \cdots \\ (a_{n1},b_{n1},c_{n1},d_{n1}) & (a_{n2},b_{n2},c_{n2},d_{n2}) & (a_{n3},b_{n3},c_{n3},d_{n3}) & (1,1,1,1) \end{bmatrix} \quad (6)$$

We use here the PWC matrix in the Eq. (3), and then we apply logarithmic on the following Eq. (7). This LFTA judgment $\tilde{a}_{ij}$ is looked as close to TFN and the membership degree can consequently be represented as:

$$\ln = \left(\ln a_{ij}, \ln b_{ij}, \ln c_{ij}, \ln d_{ij}\right), \quad i,j = 1,\ldots,n. \quad (7)$$

$$\mu_{ij}\left(\ln\left(\frac{E_i}{E_j}\right)\right) = \begin{cases} \dfrac{\ln\left(E_i/E_j\right) - \ln(a_{ij})}{\ln(b_{ij}) - \ln(a_{ij})}, & \ln\left(\dfrac{E_i}{E_j}\right) \le b_{ij}, \\ \ln(1) = 0, \quad b_{ij} \le \ln\left(\dfrac{E_i}{E_j}\right) \le c_{ij}, \\ \dfrac{\ln(d_{ij}) - \ln\left(E_i/E_j\right)}{\ln(d_{ij}) - \ln(c_{ij})}, & \ln\left(\dfrac{E_i}{E_j}\right) \ge c_{ij}, \end{cases} \quad (8)$$

Here, $\mu_{ij}(\ln (E_i/E_j))$ is represented the membership degree for the ln (E_i/E_j) that estimated accurately the LFTA decision $\ln\tilde{a}_{ij} = (\ln a_{ij}, \ln b_{ij}, \ln c_{ij}, \ln d_{ij})$. To obtain a crisp weight vector for maximize and minimize, the membership degree presented below in the Eq. (14).

$$\beta = \min\left\{\mu_{ij}\left(\ln\left(\frac{E_i}{E_j}\right)\right) \middle| \quad i = 1,\ldots,n-1; \quad j = i+1,\ldots,n\right\} \quad (9)$$

In conclusion, the outcome approach can be generated of maximizing the membership degree β

$$\text{Subject to} \begin{cases} \mu_{ij} \ln\left(\frac{E_i}{E_j}\right) \ge \beta, \ i = 1,\ldots,n-1; \ j = i+1,\ldots,n, \\ E_i \ge 0, \ i = 1,\ldots,n. \end{cases} \quad (10)$$

$$\text{To maximize the membership degree } (1-\beta) \quad (11)$$

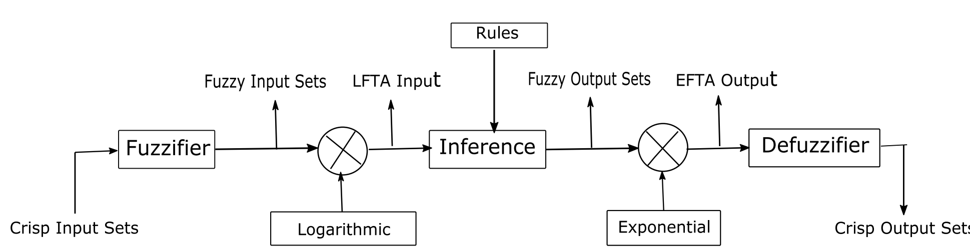


Fig. 3 Block diagram of proposed approach ‘LFTA’

Subject to

$$\begin{cases} -\ln E_i + E_j + \beta \ln(b_{ij}/a_{ij}) \geq \ln(a_{ij}), i = 1, \ldots, n-1; j = i+1, \ldots, n \\ \ln E_i - E_j + \beta \ln(d_{ij}/c_{ij}) \geq -\ln(d_{ij}), i = 1, \ldots, n-1; j = i+1, \ldots, n \\ E_i \geq 0, i = 1, \ldots, n. \end{cases} \quad (12)$$

Generally, here is no certification of Eq. (12) that will generate positive value at each instant for the membership degree (β). Here is the main cause at the back generating a value which is negative for membership function β. The meaning of this meaningless value is that it assigns no fuzzy weights that can achieve the fuzzy judgments inside the support intervals. Finally, there is not all little of equalities $\ln E_i - \ln E_j - \beta \ln (b_{ij}/a_{ij}) \geq \ln a_{ij}$ or $-\ln E_i + \ln w_j - \beta \ln (d_{ij}/c_{ij}) \geq -\ln d_{ij}$, it may be holding at same time.

To keep away from 'β' for permitting a value which is negative, a new technique introduced to generate positive value examination of new the variables γ_{ij} and σ_{ij} for the values $i = 1, \ldots, n-1$ and $j = i+1, \ldots, n$ so that they carry jointly the subsequent inequalities.

$$\text{In}E_i - InE_j - \text{In}(b_{ij}/a_{ij}) + \gamma_{ij} \geq \text{In}a_{ij}, i = 1, \ldots, n-1; j = i+1, \ldots, n, \quad (13)$$

$$-\text{In}E_i + \text{In}E_j - \text{In}\left(\frac{d_{ij}}{c_{ij}}\right) + \sigma_{ij} \geq -\text{In}d_{ij}, i = 1, \ldots, n-1; j = i+1, \ldots, n \quad (14)$$

This is the mainly desirable aspects so these values of the 'evaluated variables' have improved and less important. So suggested the 'LFTA' technique which is given below nonlinear priority approach for FAHP priority observation:

$$k = (1-\beta)^2 + M \cdot \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \left(\gamma_{ij}^2 + \sigma_{ij}^2\right) \quad (15)$$

Subject to

$$\begin{cases} z_i - z_j - \beta \text{In}\left(\frac{b_{ij}}{a_{ij}}\right) + \gamma_{ij} \geq \text{In}a_{ij}, i = 1, \ldots, n-1; j = i+1, \ldots, n, \\ -z_i + z_j - \beta \text{In}\left(\frac{d_{ij}}{c_{ij}}\right) + \sigma_{ij} \geq -\text{In}d_{ij}, i = 1, \ldots, n-1; j = i+1, \ldots, n \\ \beta, z_i \geq 0, i = 1, \ldots, n, \\ \gamma_{ij}, \sigma_{ij} \geq 0, i = 1, \ldots, n-1; j = i+1, \ldots, n, \end{cases} \quad (16)$$

Formerly the above linear equation; then we identify the two approaches that may generate different most favorable results that are dismissed. Let $z_i^*(i = 1, \ldots, n)$ exist the best optimal value of Eq. (16). These weight priorities of the fuzzy PWC matrix $J = \tilde{a}_{ij_{n*n}}$ which can be achieved:

$$E_i^* = \frac{\exp(Z_i^*)}{\sum_{i=1}^{n} \exp\left(Z_j^*\right)}, i = 1, \ldots, n, \quad (17)$$

Here, exp () is representing an exponential function, named as $\exp(z_i^*) = e^{z_i^*}$ for $i = 1, \ldots, n$. We state in this approach that exploits Eq. (16) for the FAHP weight priority evaluation as LFTA approach and resulting weight priorities as LFTA priorities. Finally the regard of LFTA approach, we have the following two statements.

(a) **First Statement**: The fuzzy weights concluding by proposed method using LFTA are that the results of lower elements of the triangular PWC matrix are accurately same as the results from upper elements of the triangular PWC matrix.
(b) **Second Statement**: This method 'LFTA' generates unique optimal solutions in the form of reliable and consistent fuzzy weight priority vector for every fuzzy PWC matrix.
(c) **Decision authentication Approach**: Lastly, the information of fuzzy approach generated by LFTA is presented to the judges. Then judges resolve a critical selection through optimal decisions.

5 Result Estimation

In the result estimation part, we explained the results of our proposed method naming as LFTA through one real-life example. Here, we tested three mathematical examples. First two mathematical examples are acquired from the existing reference paper to authenticate the proposed approach and third example took to prove the proposed approach that is more precise, persuade to obtain most excellent judgment vector through the proposed LFTA methodology to reveal its prospective applications and the advantages in fuzzy decision making over EA's weight priority on the real-time examples.

Example: We take a real-life problem for the 'selection of rank 1 college issue' in front of the students like in the Celik et al. (2009) of 'ship registry selection' that has hierarchical formation in the selection of rank 1 college as shown in Fig. 4.

In this diagram, C_1, C_2, and C_3 are the selection parameters. While each selection parameter has multiple

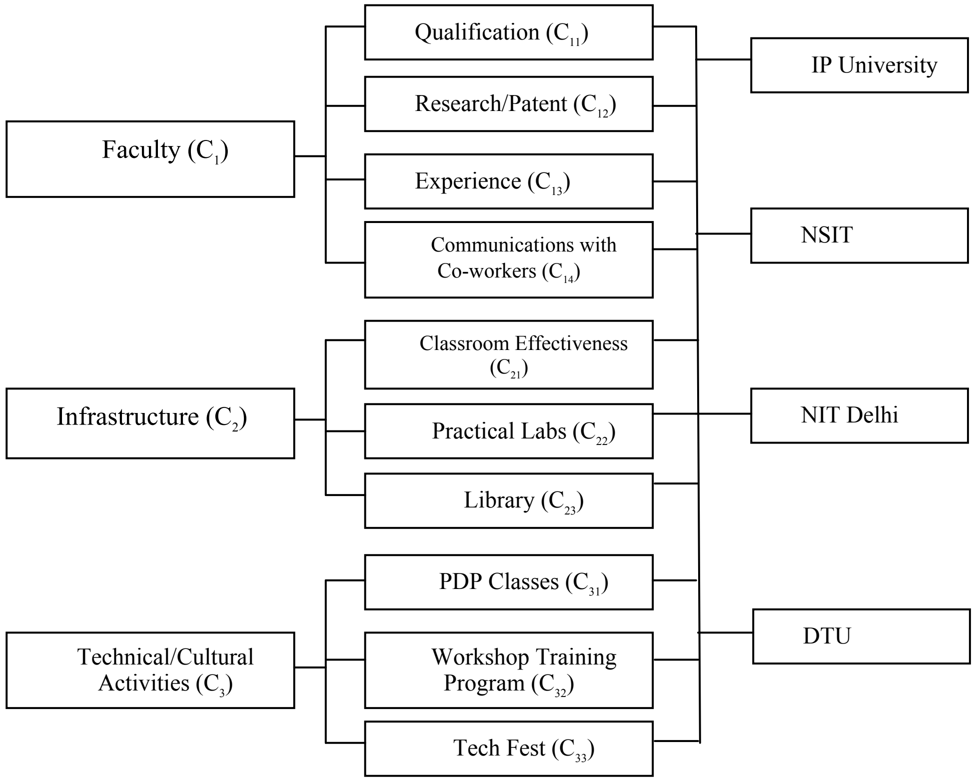


Fig. 4 Hierarchical formations for the 'college selection problem'

sub-decision parameters. Students select best college among NIT Delhi, NSIT, IP University, and DTU based on their required selection criteria's. Celik et al. (2009) presented a problem named as 'selection of ship registry' through EA technique which has found to be intolerable and unreliable and may generated the wrong outcomes. EA priority approach allocates a zero fuzzy weight priority to every of the judgment criteria C_2 and C_3. If priorities weights were found zero for C_2 and C_3, then these two decision criteria's must never considered. Finally, allocating a zero fuzzy weight priority to any of the sub-decision parameter inside the tree formations in Fig. 4 made no sense. So, the EA must be declined. So, we reexamine on the problem of 'rank 1 college selection' through this method 'LFTA' to produce precise results. Tables 1, 2, 3, 4, 5, 6 and 7 reveal fuzzy PWC matrices obtained for 'rank 1 college's choices problem'.

The hierarchical formation for 'rank 1 college selection' using 'faculty' parameter by using EA:

Table 1 Fuzzy PWC matrix for selection criteria regarding its priorities weights and judgment goal

Criteria	C_1	C_2	C_3	LFTA	EA priorities (Celik et al., 2009)
C_1	(1,1,1,1)	(3/2,2,3,7/2)	(3/2,2,3,7/2)	0.4407	1
C_2	(2/7,1/3,1/2,2/3)	(1,1,1,1)	(2/3,1,2,5/2)	0.3121	0
C_3	(2/7,1/3,1/2,2/3)	(2/5,1/2,1,3/2)	(1,1,1,1)	0.2472	0
$\beta = 0.4$					

Table 2 Fuzzy PWC matrix for the four sub-criteria of 'faculty (C_1)' and its normalized LFTA priorities weights

Criteria	C_{11}	C_{12}	C_{13}	C_{14}	LFTA	EA priorities (Celik et al., 2009)
C_{11}	(1,1,1,1)	(5/2,2,1,1/2)	(1,1/2,1/3,1/4)	(2/3,1/2,1/3,1/5)	0.1854	0.1413
C_{12}	(2,1,1/2,2/5)	(1,1,1,1)	(2/5,1/2,1/3,1/5)	(2/3,1,2,5/2)	0.2818	0.1797
C_{13}	(1,2,3,4)	(2/5,1/2,1,3/2)	(1,1,1,1)	(2/5,1/2,1,2)	0.2143	0.2610
C_{14}	(5,3,2,3/2)	(4,5,2,4)	(1/2,1,1/2,5/2)	(1,1,1,1)	0.3485	0.4179
$\beta = 0.11$						

The hierarchical formation for 'rank 1 college selection' using 'infrastructure' parameter by using EA:

Table 3 Fuzzy PWC matrix for the sub-criteria 'Infrastructure (C_2)' and its normalized LFTA priorities weights

Criteria	C_{21}	C_{22}	C_{23}	LFTA	EA priorities (Celik et al., 2009)
C_{21}	(1,1,1,1)	(2/5,1/2,2/3,1)	(1,1,1,1)	0.3195	0
C_{22}	(1,3/2,2,5/2)	(1,1,1,1)	(5/2,3,7/2,9/2)	0.4176	1
C_{23}	(1,1,1,1)	(2/9,2/7,1/3,2/5)	(1,1,1,1)	0.2627	0
$\beta = 0.561$					

The hierarchical formation for 'rank 1 college selection' using 'technical and cultural activity' parameter by using EA:

Table 4 Fuzzy PWC of selection sub-criteria 'technical/cultural activity (C_3)' and its normalized LFTA priorities weights

Criteria	C_{31}	C_{32}	C_{33}	LFTA	EA priorities (Celik et al., 2009)
C_{31}	(1,1,1,1)	(2/3,1/2,2/3,1)	(2/5,1/2,1,3/2)	0.3674	0.1461
C_{32}	(1,3/2,2,3/2)	(1,1,1,1)	(5/2,1/2,1/3,1/5)	0.3322	0.1461
C_{33}	(2/3,1,2,5)	(5,3,2,2/5)	(1,1,1,1)	0.3004	0.7078
$\beta = 0.508$					

Table 5 Fuzzy PWC matrix of the colleges concerning the sub-criteria of C_1 and their normalized priorities weights

	IP University	NSIT	NIT Delhi	DTU	LFTA	EA priorities (Celik et al., 2009)
A: College's comparisons concerning the sub-criterion C_{11}						
IPU	(1,1,1,1)	(2/7,1/5,1/3,2/5)	(2/9,1/4,2/7,1/3)	(2/3,1,3/2,2)	0.3234	0
NSIT	(5/2,3,5/2,7/2)	(1,1,1,1)	(3/2,2,5/2,3)	(3/2,2,5/2,3)	0.2800	0.5239
NIT	(3,7/2,4,9/2)	(1/3,2/5,1/2,2/3)	(1,1,1,1)	(3/2,2,3,7/2)	0.2101	0.4761
DTU	(2,2/3,1,3/2)	(1/3,2/5,1/2,2/3)	(7/2,1/3,1/2,2/3)	(1,1,1,1)	0.1865	0
$\beta = 0.25$						
B: College's comparisons concerning the sub-criterion C_{12}						
IPU	(1,1,1,1)	(2/5,1/2,1,3/2)	(2/7,1/3,2/5,1/2)	(5/2,2,1,1/2)	0.1853	0
NSIT	(2/3,1,1/2,5/2)	(1,1,1,1)	(2/5,1/2,3/5,2\3)	(3/2,2,5/2,3)	0.2305	0.3482
NIT	(2,5/2,3,7/2)	(3/2,5/3,2,5/2)	(1,1,1,1)	(3/2,2,5/2,3)	0.1702	0.6518
DTU	(2,1,1/2,2/5)	(1/3,2/5,1/2,2/3)	(1/3,2/5,1/2,2/3)	(1,1,1,1)	0.4128	0
$\beta = 0.24$						
C: College's comparisons concerning the sub-criterion C_{13}						
IPU	(1,1,1,1)	(2/3,1,1/2,5/2)	(2/3,1,3/2,2)	(2/5,1/2,2/3,1)	0.2113	0.1645
NSIT	(2/5,1/2,1,3/2)	(1,1,1,1)	(2/3,1,3/2,2)	(2/5,1/2,2/3,1)	0.2813	0.1645
NIT	(1/2,2/3,1,3/2)	(1/2,2/3,1,3/2)	(1,1,1,1)	(2/5,1/2,2/3,1)	0.2104	0.1645
DTU	(1,3/2,2,5/2)	(1,3/2,2,5/2)	(1,3/2,2,5/2)	(1,1,1,1)	0.3005	0.1645
$\beta = 0.13$						
D: College's comparisons concerning the sub-criterion C_{14}						
IPU	(1,1,1,1)	(2/9,1/4,2/7,1/2)	(2/7,1/3,2/5,1/2)	(2/5,1/2,2/3,1)	0.2130	0
NSIT	(2,7/2,2,4,9/2)	(1,1,1,1)	(2/3,1,3/2,5/2)	(2/3,1,3/2,5/2)	0.3023	0.4076
NIT	(2,5/2,3,7/2)	(5/2,2/3,1,3/2)	(1,1,1,1)	(3/2,2,5/2,3)	0.2152	0.4076
DTU	(1,3/2,2,5/2)	(5/2,2/3,1,3/2)	(1/3,2/5,1/2,2/3)	(1,1,1,1)	0.2154	0.1847
$\beta = 0.37$						

Table 6 Fuzzy PWC matrix of colleges concerning the sub-criteria of C_2 and their normalized priorities weights

	IP University	NSIT	NIT Delhi	DTU	LFTA	EA priorities (Celik et al., 2009)
A: College's comparisons concerning the sub-criterion C_{21}						
IPU	(1,1,1,1)	(2/3,1,2,5/2)	(2/5,1/2,2/3,1)	(2/5,1/2,2/3,1)	0.2405	0.0717
NSIT	(2/5,1/2,1,3/2)	(1,1,1,1)	(1,1,1,1)	(2/3,1,2,5/2)	0.3122	0.2164
NIT	(1,3/2,2,5/2)	(1,1,1,1)	(1,1,1,1)	(3/2,2,5/2,3)	0.2360	0.4305
DTU	(1,3/2,2,5/2)	(2/5,1/2,1,3/2)	(1/3,2/5,1/2,2/3)	(1,1,1,1)	0.2136	0.2815
β = 0.51						
B: College's comparisons concerning the sub-criterion C_{22}						
IPU	(1,1,1,1)	(1/3,2/5,1/2,2/3)	(2,1/2,5/2,3)	(1,3/2,2,5/2)	0.2012	0.4199
NSIT	(1/2,1/3,1/4,1/5)	(1,1,1,1)	(1,2,3,5)	(2/3,1,2,5/2)	0.3701	0.2349
NIT	(2/7,1/3,2/5,1/2)	(1/5,1/3,1/2,1)	(1,1,1,1)	(3/2,2,5/2,3)	0.2003	0.3136
DTU	(1/3,2/5,1/2,2/3)	(1/3,2/5,1/2,2/3)	(1/3,2/5,1/2,2/3)	(1,1,1,1)	0.1875	0.0316
β = 0.58						
C: College's comparisons concerning the sub-criterion C_{23}						
IPU	(1,1,1,1)	(1/2,1/3,1/4,1/5)	(1/2,1/3,1/4,1/5)	(1/2,1/3,1/4,1/5)	0.3471	0.5343
NSIT	(1/3,2/5,1/2,2/3)	(1,1,1,1)	(1/2,1/3,1/4,1/5)	(1/2,1/3,1/4,1/5)	0.2457	0.3850
NIT	(1/3,2/5,1/2,2/3)	(1/3,2/5,1/2,2/3)	(1,1,1,1)	(1,4,4,4)	0.1902	0.0401
DTU	(1,5,5,4)	(1/3, 2/5,1/2,2/3)	(1/3,2/5,1/2,2/3)	(1,1,1,1)	0.3163	0.0401
β = 0.37						

Table 7 Fuzzy PWC matrix of colleges concerning the sub-criteria of C_3 and their normalized priorities weights

	IP University	NSIT	NIT Delhi	DTU	LFTA	EA priorities (Celik et al., 2009)
A: Comparisons of colleges concerning the sub-criterion C_{31}						
IPU	(1,1,1,1)	(1/3,2/5,1/2,2/3)	(1/3,2/5,1/2,2/3)	(2/3,1,2,5/2)	0.1625	0.4313
NSIT	(1/3,2/5,1/2,2/3)	(1,1,1,1)	(1,1,1,1)	(1/3,2/5,1/2,2/3)	0.6798	0.2633
NIT Delhi	(1/3,2/5,1/2,2/3)	(1,1,1,1)	(1,1,1,1)	(1/3,2/5,1/2,2/3)	0.0680	0.0194
DTU	(2/5,1/2,1,3/2)	(1/3,2/5,1/2,2/3)	(1/3,2/5,1/2,2/3)	(1,1,1,1)	0.0900	0.2860
β = 0.78						
B: Comparisons of colleges concerning the sub-criterion C_{12}						
IPU	(1,1,1,1)	(2/9,1/4,1/3,2/5)	(5/2,3,7/2,4)	(1/3,2/5,1/2,2/3)	0.2601	0.3663
NSIT	(5/2,3,4,9/2)	(1,1,1,1)	(1,1,1,1)	(1/3,2/5,1/2,2/3)	0.5358	0.6363
NIT Delhi	(1/4,2/7,1/3,2/5)	(1,1,1,1)	(1,1,1,1)	(1/3,2/5,1/2,2/3)	0.0866	0
DTU	(2/5,1/2,1,3/2)	(2/5,1/2,1,3/2)	(2/5,1/2,1,3/2)	(1,1,1,1)	0.1152	0
β = 0.90						
C: Comparisons of colleges concerning the sub-criterion C_{13}						
IPU	(1,1,1,1)	(2/9,1/4,1/3,2/5)	(2/3,1,2,5/2)	(2/5,1/2,1,3/2)	0.2420	0
NSIT	(5/2,3,4,9/2)	(1,1,1,1)	(1/3,2/5,1/2,2/3)	(1/3,2/5,1/2,2/3)	0.5634	0.8621
NIT Delhi	(2/5,1/2,1,3/2)	(3/2,2,5/2,3)	(1,1,1,1)	(2/3,1,2,5/2)	0.08347	0
β = 0.22	(2/3,1,2,5/2)	(3/2,2,5/2,3)	(5/2,1/2,1,3/2)	(1,1,1,1)	0.1112	0.1379

The weights for the priorities computed through the proposed technique named as LFTA which is shown by headline within the columns 'LFTA priorities' in the last columns of each table. Table 8 represents the aggregated weight priorities. Finally, the 'LFTA method' computes 'NSIT' is the rank 1 college, while the EA generates a different outcome that choose 'NIT Delhi' got the second rank. Through this case study, it has been found that results generated using this approach are a more reliable and consistent than provided by the EA. Therefore, we have the reasons to decline the results provided through EA.

Table 8 Accumulation of the overall weights for priorities obtained by LFTA

Overall weight priorities for the ranking of colleges about the decision goal				
Weight	0.4407	0.3121	0.2472	-
IP University	0.23325ss	0.267	0.1244	0.2082
NSIT	**0.27285**	**0.30866**	**0.2736**	**0.285**
NIT Delhi	0.2020	0.20866	0.4264	0.279
DTU	0.2876	0.239	0.1756	0.2340

6 Conclusion

RP is a very significant phase to build optimal judgments. Through the existing research work, it has been noted that no technique does not perform sound for grading the alternatives and go through a various drawbacks like uncertainty, complication, vagueness, and negative value of membership. To eliminate these problems for ranking the alternatives in MCDM, we introduced a novel approach using LFTA that generates positive membership degree and provides a unique best possible priority weight vector. To evaluate the effectiveness, this proposed approach applied on a problem that is 'selection of rank 1 college fully based on various selection criteria' made through students. It proves optimal priorities are exactly similar for the lower triangular elements and the upper triangular elements in the form of PWC matrix. For the future perspective, the difficulty of this technique can be enhanced through PSO and genetic algorithm (GA). Finally, 'NSIT' is rank 1 college that gained highest priority and 'NIT Delhi' got second rank based on various selection criteria.

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