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On the Use of the Linguistic Fuzzy Approaches in the Selection of Liquid Levelmeters for Nuclear Energy Facilities

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Abstract—A selection methodology of liquid levelmeters, especially, level sensors in non-nuclear category, to be installed in nuclear energy facilities is developed using linguistic fuzzy approaches such as fully-linguistic and semi-linguistic methods. Depending on defuzzification techniques, the linguistic fuzzy methodology leads to either linguistic (exactly, fully-linguistic) or cardinal (i.e., semi-linguistic) evaluation. For the linguistic method, for each alternative, fuzzy preference index is converted to linguistic utility value by means of a similarity measure determining the degree of similarity between fuzzy index and linguistic ratings. For the cardinal method, the index is translated to cardinal overall utility value. According to these values, alternatives of interest are linguistically or numerically evaluated and a suitable alternative can be selected. Under given selection criteria, the suitable selections out of some liquid levelmeters for nuclear facilities are dealt with using the linguistic fuzzy methodology proposed. Then, linguistic fuzzy evaluation results are compared with qualitative result available in the literature. It is found that as to a suitable option the linguistic fuzzy selection is in agreement with the qualitative selection. Additionally, the comparative study shows that the fully-linguistic method using adequate scale system facilitates linguistic interpretation regarding evaluation results.

1. Introduction

In the context of decision-making problems, selection problems under vague, imprecise, and uncertain information situation appear frequently in the field of energy engineering. For example, there are studies on selection of instrumentation elements such as in-vessel level meters [Lee, 1999], flowmeters [Hayward, 1975; Furness, 1993], etc. [Hewitt *et al.*, 1982; Cho, 1996]. In these studies, for easily incorporating the fuzziness into decision-making processes, the concepts of fuzzy variables and linguistic variables can be combined and the approximate reasoning be applied to selection assessment.

In this work, as for alternatives, selection evaluation will be concerned with in-vessel sensors for liquid level measurement in the reactor vessel of nuclear power plants [Kondic, 1981]. In Ref. [Hayward, 1975; Furness, 1993; Lee, 1999], instruments selection is evaluated qualitatively based on a kind of selection charts. Depending on selection objectives, different decision criteria, namely, selection criteria, are taken into consideration in the literature [Hsu, 1974; Brockett/Johnson, 1976; Lee, 1999].

According to the grade of combination of the linguistic variable and fuzzy variable, a fully-linguistic or semi-linguistic method is applicable to defuzzify preference indices expressed by fuzzy numbers. To deal with the interlinkage between linguistic variable and fuzzy variable, it is necessary for a conversion table to be applied to two phases. As the first phase, based on empirical data and/or engineering judgment, linguistic values assigned to decision variables are translated into trapezoidal fuzzy numbers for facilitating the fuzzy arithmetic operations for aggregation and cardinality (i.e., ranking). Secondly, using a similarity function, fuzzy preference index as an aggregation measure is translated into linguistic utility value. For semi-linguistic method, the first conversion is needed only, whereas both conversions are necessary in the case of fully-linguistic method.

Regarding the instruments selection, there is few investigation based on linguistic approach, despite of the fuzziness knowledge environment. Therefore, it is an interesting need that linguistic approaches should be developed for handling the problem of instrument selection. The main purpose of the present work is to develop a linguistic fuzzy methodology for suitable selection of liquid levelmeters applicable to existing nuclear facilities under mixed (i.e., partially objective and partially subjective), limited, incomplete, and/or vague knowledge environment.

2. Linguistic Fuzzy Selection Methodology

Linguistic values are used for describing DM's assignment based on experts' judgment on decision variables. Linguistic variable denotes a variable whose values are not numbers but words or phrases in a natural or synthetic language. For the importance weight, using *nw*-member scale, the linguistic term set is expressed by T(importance weight) $\equiv TW = \{TW_S \mid s = 1, 2, \dots, nw\}$. The linguistic term set of *ns*-member scale for the preference rating is described as T(preference rating) $\equiv TS = \{TS_s \mid s = 1, 2, \ldots, ns\}$. Here s denotes the scale index used in linguistic/fuzzy conversion tables for the importance weight and preference rating.

A trapezoidal fuzzy number N denoted by (a, b, c, d), a fuzzy subset in the universe of discourse X, can be used for treating vagueness. Its membership function $f_N(x)$: $X \rightarrow [0,1]$ indicating the grade of membership of x in fuzzy set N is analytically formulated as Eq. (2-1):

$$f_N(x) = \begin{cases} 0 & \text{for } -\infty < x \le a, \\ \dfrac{x-a}{b-a} & \text{for } a \le x \le b, \\ 1 & \text{for } b \le x \le c, \\ \dfrac{x-d}{c-d} & \text{for } c \le x \le d, \\ 0 & \text{for } d \le x < +\infty. \end{cases} \qquad (2\text{-}1)$$

where a, b, c, and d are real numbers.

In this work, using the fuzzy arithmetic operations of trapezoidal fuzzy numbers, aggregation and cardinality of fuzzy values associated with decision variables are easy to implement. The fuzzy arithmetic operations for aggregation of fuzzy decision matrices are needed in both cases of fully-linguistic and semi-linguistic methods. Concerning cardinality of various decision alternatives associated with fuzzy preference indices, the fuzzy operations are implemented only for semi-linguistic method. Related to similarity measure of various decision alternatives, the calculation is executed only for fully-linguistic method.

Aggregation of fuzzy numbers for obtaining fuzzy preference index

A fuzzy preference index is viewed as an aggregation measure for various decision alternatives under decision criteria. Let $A = \{A_i \mid i = 1, 2, \ldots, m\}$ be a set of m alternatives under consideration and $C = \{C_t \mid t = 1, 2, \ldots, k\}$ a set of k decision criteria. Let S_{it} be the preference rating of alternative A_i for decision criterion C_t, W_t the importance weight for decision criterion C_t.

The fuzzy preference index F_i for alternative A_i is calculated via fuzzy arithmetic operations of S_{it} and W_t [Chang and Chen, 1994]. This preference index describes the degree of appropriateness for the alternative. Based on the arithmetic mean method, F_i can be expressed by Eq. (2-2):

$$F_i = \frac{1}{k} \otimes \left[(S_{i1} \otimes W_1) \oplus (S_{i2} \otimes W_2) \oplus \cdots \oplus (S_{it} \otimes W_t) \oplus \cdots \oplus (S_{ik} \otimes W_k) \right], \qquad (2\text{-}2)$$

Treating S_{it} and W_t with trapezoidal fuzzy numbers, that is, $S_{it} = (o_{it}, p_{it}, q_{it}, r_{it})$ and $W_t = (a_t, b_t, c_t, d_t)$, F_i is approximately written for the alternative index $i = 1, 2, \ldots, m$ and the criterion index $t = 1, 2, \ldots, k$ as Eq. (2-3):

$$F_i \cong (V_i, X_i, Y_i, Z_i), \qquad (2\text{-}3a)$$

with

$$V_i = \sum_{t=1}^{k} \frac{o_{it}\, a_t}{k},\ X_i = \sum_{t=1}^{k} \frac{p_{it}\, b_t}{k},\ Y_i = \sum_{t=1}^{k} \frac{q_{it}\, c_t}{k},\ Z_i = \sum_{t=1}^{k} \frac{r_{it}\, d_t}{k}. \qquad (2\text{-}3b)$$

Cardinality of fuzzy numbers leading to overall utility values

Overall utility value described by cardinal number denotes a measure to rank fuzzy preference indices for various decision alternatives. The details of overall utility value $U_T(N, \alpha_T)$ can be found in Ref. [Ghyym, 1999]. In general, the alternative with the largest overall utility value is viewed as the suitable selection option.

Similarity measure for transforming fuzzy number into linguistic utility values

Linguistic utility values are obtained in terms of a similarity measure between fuzzy number and preference rating described by fuzzy number corresponding to linguistic value. In this work, the similarity measure reported in Ref. [Chen, 1996] is used. For two trapezoidal fuzzy numbers $N_1 = (a_1, b_1, c_1, d_1)$ and $N_2 = (a_2, b_2, c_2, d_2)$, a similarity value is calculated by the similarity function $H_1(N_1, N_2)$ as Eq. (2-4a), where $H_1(N_1, N_2) \in [0, 1]$. To investigate the effect of similarity measures on the linguistic utility value, the similarity function $H_2(N_1, N_2)$

$\in [0, 1]$, Eq. (2-4b), described in Ref. [Zwick *et al.*, 1987] is used as well. The larger similarity values indicate the higher degree of similarity:

$$H_1(N_1, N_2) = 1 - \frac{|a_1 - a_2| + |b_1 - b_2| + |c_1 - c_2| + |d_1 - d_2|}{4}, \quad (2\text{-}4a)$$

$$H_2(N_1, N_2) = \sup_{x \in X} f_{N_1 \cap N_2}(x). \quad (2\text{-}4b)$$

Assume that a *ns*-element scale conversion table is used. Let TS_S be linguistic value of linguistic term set of preference rating such as $TS = \{TS_S \mid s = 1, 2, \ldots, ns\}$ represented by the fuzzy number $N_S = (a_S, b_S, c_S, d_S)$. Let F_i be the fuzzy preference index for alternative index $i = 1, 2, \ldots, m$. Using the similarity function H_1 or H_2, for the scale index $s = 1, 2, \ldots, ns$, the similar values p_{Si} corresponding to F_i are calculated by Eq. (2-5) or (2-6).

$$P_{si} = H_1(F_i, TS_s), \quad (2\text{-}5a)$$

with

$$H_1(F_i, TS_s) = 1 - \frac{|V_i - a_s| + |X_i - b_s| + |Y_i - c_s| + |Z_i - d_s|}{4}, \quad (2\text{-}5b)$$

or

$$P_{si} = H_2(F_i, TS_s), \quad (2\text{-}6a)$$

where

$$H_2(F_i, TS_s) = \sup_{x \in X} f_{F_i \cap TS_s}(x). \quad (2\text{-}6b)$$

Then, the linguistic utility value $U_L(F_i)$ for alternative i can be obtained using Eq. (2-7).

$$U_L(F_i) = TS_{smx} \text{ with } smx = s \ni \max_{s=1,\ldots,ns}(p_{1i}, p_{2i}, \ldots, p_{nsi}) \quad (2\text{-}7)$$

Procedure of linguistic fuzzy selection

The linguistic fuzzy methodology developed for obtaining a suitable option is made up of (1) the hierarchical construction task; (2) the assignment task; (3) the fuzzification task; and (4) the defuzzification task. The details of the procedure developed can be found in Ref. [Ghyym, 1999].

3. Application of Linguistic Fuzzy Selection Methodology to Liquid Levelmeters

In the present work, the methodology depicted above is applied to illustrate the suitable selection for non-nuclear levelmeters for measuring in-vessel liquid level in existing nuclear facilities. One study case available in the literature [Lee, 1999] is investigated using the linguistic fuzzy selection methodology proposed. In addition, a comparison with other approaches is mentioned. For the **study case**, a qualitative selection is implemented in Ref. [Lee, 1999].

Study case: comparison with qualitative selection

For the **study case**, the developed procedure is followed. The five candidates considered in Ref. [Lee, 1999] are as follows: A_1 = conductivity probe; A_2 = microwave meter; A_3 = heated thermocouple meter; A_4 = ultrasonic transducer; and A_5 = differential pressure transducer. The eight selection criteria considered are: C_1 = ease of interpretation; C_2 = measurement accuracy; C_3 = use of proven technology; C_4 = reliability; C_5 = survivability; C_6 = ease of installation/retrofit; C_7 = maintainability; and C_8 = economy. Thus, five-element alternative matrix is $A = \{A_1, A_2, A_3, A_4, A_5\}$ and eight-element criteria matrix $C = \{C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8\}$.

In the Ref. [Lee, 1999], the assignment was conducted qualitatively with nine-member scale such as {C-, C0, C+, B-, B0, B+, A-. A0, A+} with respect to preference rating. The assignment of importance weight was not reported. In Table 3-1, for nine-member scale, it is assumed that the importance weight of criteria is assigned using {U, B.U&SL, SL, B.SL&VH, VH, M, B.M&SE, SE, B.SE&VSE, VSE} and the preference rating using {W, VP, P, FP, F, FG, G, VG, B}. The importance weight matrix, preference rating matrix, and preference index are summarized in Table 3-2.

Table 3-1 Nine-member scale conversion table for linguistic value and fuzzy number

For W, S	For importance weight W		For preference rating S	
Grade	Linguistic value	Fuzzy number	Linguistic value	Fuzzy number
C-	U	(0, 0, 0, 0.2)	W	(0, 0.1, 0.1, 0.2)
C0	B.U&SL	(0, 0, 0.2, 0.4)	VP	(0.1, 0.2, 0.2, 0.3)
C+	SL	(0, 0.2, 0.2, 0.4)	P	(0.2, 0.3, 0.3, 0.4)
B-	B.SL&VH	(0, 0.2, 0.5, 0.7)	FP	(0.3, 0.4, 0.4, 0.5)
B0	M	(0.3, 0.5, 0.5, 0.7)	F	(0.4, 0.5, 0.5, 0.6)
B+	B.M&SE	(0.3, 0.5, 0.8, 1)	FG	(0.5, 0.6, 0.6, 0.7)
A-	SE	(0.6, 0.8, 0.8, 1)	G	(0.6, 0.7, 0.7, 0.8)
A0	B.SE&VSE	(0.6, 0.8, 1, 1)	VG	(0.7, 0.8, 0.8, 0.9)
A+	VSE	(0.8, 1, 1, 1)	B	(0.8, 0.9, 0.9, 1)

Table 3-2 Fuzzy matrices and fuzzy preference index

		A_1	A_2	A_3	A_4	A_5
C_1	(0.8,1,1,1)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.1,0.2,0.2,0.3)
C_2	(0.8,1,1,1)	(0.4,0.5,0.5,0.6)	(0.1,0.2,0.2,0.3)	(0.7,0.8,0.8,0.9)	(0.4,0.5,0.5,0.6)	(0.7,0.8,0.8,0.9)
C_3	(0.8,1,1,1)	(0.3,0.4,0.4,0.5)	(0.1,0.2,0.2,0.3)	(0.4,0.5,0.5,0.6)	(0.4,0.5,0.5,0.6)	(0.7,0.8,0.8,0.9)
C_4	(0.8,1,1,1)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)
C_5	(0.8,1,1,1)	(0.4,0.5,0.5,0.6)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.4,0.5,0.5,0.6)
C_6	(0.8,1,1,1)	(0.1,0.2,0.2,0.3)	(0.1,0.2,0.2,0.3)	(0.7,0.8,0.8,0.9)	(0.4,0.5,0.5,0.6)	(0.1,0.2,0.2,0.3)
C_7	(0.8,1,1,1)	(0.7,0.8,0.8,0.9)	(0.4,0.5,0.5,0.6)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)
C_8	(0.8,1,1,1)	(0.7,0.8,0.8,0.9)	(0.4,0.5,0.5,0.6)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.4,0.5,0.5,0.6)
F_i		(0.4,0.6,0.6,0.7)	(0.32,0.5,0.51,0.6)	(0.53,0.76,0.76,0.86)	(0.47,0.69,0.69,0.79)	(0.38,0.58,0.58,0.68)

Based on semi-linguistic method, using the total integral values with the calculated risk attitude index of α_T = 0.583, the overall utility values calculated as well as ranking order are shown in Table 3-3. For fully-linguistic method, similarity values and linguistic utility values using the similarity function H_1 obtained are shown in Table 3-3. As shown in Table 3-3, for the fully-linguistic approach, both heated thermocouple meter (i.e., A_3) and ultrasonic transducer (i.e., A_4) are suitable levelmeters because these are represented as good. According to the nine-member scale conversion table used, the results are in agreement with those for the qualitative approach. For the semi-linguistic approach, heated thermocouple meter (i.e., A_3) is viewed as suitable levelmeter.

Table 3-3 Linguistic utility value and overall utility value each alternative A_i

	Similarity value				
	A_1	A_2	A_3	A_4	A_5
$H(F_i$, Worst)	0.525	0.62	0.370625	0.441875	0.54875
$H(F_i$, Very-poor)	0.625	0.72	0.470625	0.541875	0.64875
$H(F_i$, Poor)	0.725	0.82	0.570625	0.641875	0.74875
$H(F_i$, Fairly-poor)	0.825	0.92	0.670625	0.741875	0.84875
$H(F_i$, Fair)	0.925	**0.98**	0.770625	0.841875	0.93875
$H(F_i$, Fairly-good)	**0.975**	0.88	0.870625	0.926875	**0.9513**
$H(F_i$, Good)	0.875	0.78	**0.93563**	**0.95813**	0.85125
$H(F_i$, Very-good)	0.775	0.68	0.929375	0.858125	0.75125
$H(F_i$, Best)	0.675	0.58	0.829375	0.758125	0.65125
Linguistic utility value	FG	Fair	**Good**	**Good**	FG
Overall U. V. (Ranking order)	0.5875 (3)	0.4917 (5)	0.7432 (1)	0.6714 (2)	0.5635 (4)
Qualitative grade [Lee, 1999]	B+	B0	A-	A-	B+

Effect of scale systems. In Table 3-4, it is assumed that based on three-member scale the importance weight of criteria is assigned using {L, M, H} and the preference rating using {P, F, G}. The importance weight and preference rating matrices as well as preference index are summarized in Table 3-5.

Table 3-4 Three-member scale conversion table for linguistic value and fuzzy number

For W, S	For importance weight W		For preference rating S	
Grade	Linguistic value	Fuzzy number	Linguistic value	Fuzzy number
C	Low (L)	(0, 0, 0, 0.5)	Poor (P)	(0, 0, 0, 0.5)
B	Medium (M)	(0.25, 0.5, 0.5, 0.75)	Fair (F)	(0.2, 0.5, 0.5, 0.8)
A	High (H)	(0.5, 1, 1, 1)	Good (G)	(0.7, 1, 1, 1)

Table 3-5 Fuzzy matrices and fuzzy preference index

		A_1	A_2	A_3	A_4	A_5
C_1	(0.25,0.5,0.5,0.75)	(0.7,1,1,1)	(0.7,1,1,1)	(0.7,1,1,1)	(0.7,1,1,1)	(0,0,0,0.5)
C_2	(0.25,0.5,0.5,0.75)	(0.2,0.5,0.5,0.8)	(0,0,0,0.5)	(0.7,1,1,1)	(0.2,0.5,0.5,0.8)	(0.7,1,1,1)
C_3	(0.25,0.5,0.5,0.75)	(0.2,0.5,0.5,0.8)	(0,0,0,0.5)	(0.2,0.5,0.5,0.8)	(0.2,0.5,0.5,0.8)	(0.7,1,1,1)
C_4	(0.25,0.5,0.5,0.75)	(0.7,1,1,1)	(0.7,1,1,1)	(0.7,1,1,1)	(0.7,1,1,1)	(0.7,1,1,1)
C_5	(0.25,0.5,0.5,0.75)	(0.2,0.5,0.5,0.8)	(0.7,1,1,1)	(0.7,1,1,1)	(0.7,1,1,1)	(0.2,0.5,0.5,0.8)
C_6	(0.25,0.5,0.5,0.75)	(0,0,0,0.5)	(0,0,0,0.5)	(0.7,1,1,1)	(0.2,0.5,0.5,0.8)	(0,0,0,0.5)
C_7	(0.25,0.5,0.5,0.75)	(0.7,1,1,1)	(0.2,0.5,0.5,0.8)	(0.7,1,1,1)	(0.7,1,1,1)	(0.7,1,1,1)
C_8	(0.25,0.5,0.5,0.75)	(0.7,1,1,1)	(0.2,0.5,0.5,0.8)	(0.7,1,1,1)	(0.7,1,1,1)	(0.2,0.5,0.5,0.8)
F_i		(0.11,0.34,0.34,0.65)	(0.08,0.25,0.25,0.57)	(0.16,0.47,0.47,0.73)	(0.13,0.41,0.41,0.69)	(0.1,0.31,0.31,0.62)

For semi-linguistic method, using the total integral values with the calculated risk attitude index of α_T = 0.677, the overall utility values calculated and the corresponding ranking orders are shown in Table 3-6. For fully-linguistic method, similarity values and linguistic utility values are shown in Table 3-6. As shown in Table 3-6, for the fully-linguistic approach, A_1, A_3, A_4, and A_4 are represented as fair. It is clear that the fully-linguistic approach using scale system with the number of members less than the number of alternatives to be evaluated can lead to indistinguishable results. According to the three-member scale conversion table used, the results obtained are underestimated than those for the qualitative approach. For the semi-linguistic approach, heated thermocouple meter (i.e., A_3) is viewed as suitable levelmeter. The ranking order based on 3-member scale system agrees to that using 9-member scale system.

Table 3-6 Linguistic utility value and overall utility value for each alternative A_i

	Similarity value				
	A_1	A_2	A_3	A_4	A_5
$H(F_i$, Poor)	0.764844	0.8375	0.667969	0.716406	0.78906
$H(F_i$, Fair)	0.8602	0.7875	0.95703	0.90859	0.8359
$H(F_i$, Good)	0.435156	0.3625	0.532031	0.483594	0.41094
Linguistic utility value	**Fair**	Poor	**Fair**	**Fair**	**Fair**
Overall U. V. (Ranking order)	0.4080 **(3)**	0.3312 **(5)**	0.5077 **(1)**	0.4587 **(2)**	0.3819 **(4)**
Qualitative grade [Lee, 1999]	B+	B0	A-	A-	B+

Effect of similarity measures. To study the effect of similarity functions on results based on the fully-linguistic approach proposed, using the similarity measure H_2, the linguistic utility values for both nine-element scale and three-element scale systems are evaluated. In Table 3-7, the results are listed. As shown in Table 3-7, for 9-member scale system, heated thermocouple meter (i.e., A_3) is the suitable levelmeter because it is represented as very-good. The linguistic rankings are similar to those using the similarity function H_1. For 3-member scale system, the results are the same for both similarity functions (i.e., H_1 and H_2). The effect of similarity measures investigated, thus, seems to be negligible for both 3-member scale and 9-member scale systems.

Table 3-7a Linguistic utility value for 9-element scale system

	Order of similar values	Linguistic U.V.
A_1	$H_2(F_1, FG) > H_2(F_1, F) > H_2(F_1, G) > H_2(F_1, FP)$	FG
A_2	$H_2(F_2, F) > H_2(F_2, FP) > H_2(F_2, FG) > H_2(F_2, P)$	F
A_3	$H_2(F_3, VG) > H_2(F_3, G) > H_2(F_3, FG) > H_2(F_3, B) > H_2(F_3, F)$	VG
A_4	$H_2(F_4, G) > H_2(F_4, FG) > H_2(F_4, VG) > H_2(F_4, F) > H_2(F_3, FP)$	G
A_5	$H_2(F_5, FG) > H_2(F_5, F) > H_2(F_5, FP) > H_2(F_5, G) > H_2(F_3, P)$	FG

Table 3-7b Linguistic utility value for 3-element scale system

	Order of similar values	Linguistic U.V.
A_1	$H_2(F_1, F) > H_2(F_1, P)$	Fair
A_2	$H_2(F_2, P) > H_2(F_2, F)$	Poor
A_3	$H_2(F_3, F) > H_2(F_3, P) > H_2(F_3, G)$	Fair
A_4	$H_2(F_4, F) > H_2(F_4, P)$	Fair
A_5	$H_2(F_5, F) > H_2(F_5, P)$	Fair

4. Conclusive Remarks

In the present work, based on fully-linguistic method and semi-linguistic method, a linguistic fuzzy selection methodology is proposed to aid the suitable selection decision-making of decision alternatives under multiple decision criteria regarding in-vessel levelmeter selection in a nuclear energy system. For linguistic selection, using a similarity measure suggested in Ref. [Chen, 1996], the fuzzy preference indices are transformed into linguistic utility values, whilst for cardinal selection these indices are converted to cardinal overall utility values based on total optimism index and total integral value.

It is found that as to a suitable option the linguistic fuzzy selection agrees to the qualitative selection. Compared with other qualitative evaluation, it is shown that the present linguistic fuzzy methodology facilitates linguistic interpretation regarding evaluation results in contrast with handling by means of qualitative approaches.

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