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Strategic Mapping of Youth Unemployment With Interval-Valued Intuitionistic Hesitant Fuzzy DEMATEL Based on 2-Tuple Linguistic Values

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ABSTRACT This study aims to identify the factors that affect youth unemployment in emerging countries. For this purpose, 3 dimensions and 12 criteria are selected as a result of literature review. The analysis process has 3 different steps. Firstly, interval-valued intuitionistic fuzzy sets are created with the help of 2-tuple linguistic data. Additionally, relation matrix is generated by considering these fuzzy sets. In the second process, defuzzification process is occurred. Finally, the dimensions and criteria are weighted with Decision-Making Trial and Evaluation Laboratory (DEMATEL) approach by using defuzzified data sets. The findings indicate that economic and social inequalities play the most significant role for youth unemployment in emerging countries. On the other side, it is also identified that economic crisis and insufficient education conditions are also important issues which lead to youth unemployment in these countries. Hence, it is recommended that governments should implement fair tax management practices in these countries to minimize economic and social inequalities. Furthermore, education conditions should be improved in the countries. In this framework, an effective education plan can be designed by cooperating with companies in the industry. Thus, labor needs in industry can be identified and education system can be designed according to the needs in the market. With the help of these implementations, it can be much easier for young people to find a job.

INDEX TERMS 2-tuple linguistic values, interval-valued intuitionistic fuzzy environment, fuzzy DEMATEL, NEET, emerging economies.

I. INTRODUCTION

Unemployment is an important problem for countries. This problem has negative effects both economically and socially. Unemployed people do not have regular income. Therefore, they have to keep their expenditures to a minimum. Given this fact, if the number of unemployed people in a country increases, this will have a negative impact on the trade volume in the country [1]. In addition, people become unable to pay their debts to banks when they become unemployed. This situation will adversely affect the financial system in the country. On the other hand, unemployed people do not have regular income and may experience some social problems [2]. These people may lose their self-confidence due to financial difficulties. This situation may lead to depression of these people. Since they do not have regular income, such people are likely to join to illegal means to earn income [3]. As a result, the crime rate in the country is likely to increase significantly.

These issues indicate that unemployment is a very important problem for the country. Therefore, countries are taking a number of measures to solve this problem. For example, governments are trying to encourage foreign investors by using certain opportunities such as tax advantage [4]. In this

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way, the amount of foreign direct investment in the country will increase and new people will be able to find jobs in these areas. In addition to this, increasing public investment will stimulate the economy, which will contribute to the reduction of unemployment [5]. In addition, the reduction in financial burdens, such as taxes and premiums on employment, will reduce the financial burden on the employer. As a result, company owners will be willing to employ new workers [6]. Finally, the vocational training to be provided to the people will also contribute positively to their employment.

The most prominent situation in the unemployment problem is the youth who are unemployed [7]. The group defined as Not in Education, Employment, or Training (NEET) refers to young people between the ages of 15-24, who do not work in any job and do not currently receive any training [8], [9]. In addition to this situation, these persons do not also have any job search. This situation is experienced in many different countries and country groups in the world [10], [11]. This situation is accepted as a very important social problem. For this group, governments may need to take extra measures. Young people, who do not have any qualifications and financial income, have a higher risk of getting involved in illegal activities [12], [13]. On the other hand, for these reasons, they are likely to experience psychological difficulties.

It is possible to talk about many different issues that cause young people in the country to fall into this situation. For example, parents' educational status, occupational status and income level are considered to have a significant impact on this situation. In addition, the presence of physical and mental disorders of the individuals may cause the mentioned persons to be included in this group. High rates of early school leaving, gender differences, and inappropriate employment targets are among the important reasons. On the other hand, country-wide problems, such as the economic crisis, political instability and regional disparities, can also play an important role in defining young people as NEET [14]–[16]. As can be understood from the above, there are many different aspects that can lead to the identification of young people as NEET. In order to produce a clear and effective strategy for the solution of this problem on a country basis, it is important to clearly identify the main factors causing this problem. In this context, it is necessary to determine which of these factors is more important than the other. For this purpose, the method to be used is vitally important because the analysis with the wrong method can give inaccurate results.

Multi-criteria decision making models are frequently preferred in the literature in order to choose from a large number of criteria and alternatives [17], [18]. However, use of fuzzy sets is very popular for the decision making under the uncertainty. These models are also used by many authors with fuzzy logic [19], [20]. In the literature, there are some extensions of multi-criteria decision making methods by considering the generalizations of fuzzy sets. On the other hand, interval-valued intuitionistic fuzzy sets are widely used for the complex decision making process of real-world problems. In this way, it is possible to reach more effective results in an uncertain environment.

There are some different multi-criteria decision making models to weight the criteria. For instance, Analytic Hierarchy Process (AHP) was developed by Saaty [21] to make decisions under the complex environment. It is mainly used to understand the significance levels of different criteria so that it can be much easier to reach a decision. The main advantage of this approach is its simplicity and flexibility according to the changes [22]. Nevertheless, the biggest disadvantage of AHP approach is that there is independence between the hierarchies. On the other side, Analytic Network Process (ANP) is also another multi-criteria decision-making approach which is accepted as a more general form of AHP [23] and it is structured as a network in this system [24]. Hence, the disadvantage of AHP approach can be minimized with the inner dependency among the elements in ANP system [25], [26]. In addition to these approaches, DEMATEL is also another methodology which can also be considered to weight different factors according to their significance levels. The main advantage of DEMATEL approach in comparison with AHP and ANP is to construct the impact relation map between the criteria. In other words, it involves indirect relations within a cause and effect model [27], [28].

Especially in recent years, interval-valued intuitionistic fuzzy environment and 2-tuple linguistic values are also taken into consideration by some researchers [29], [30]. This new implementation provides many different advantages. With the help of considering interval-valued intuitionistic fuzzy environment, in the analysis process, two different bands are formed: good and bad scenario. Therefore, these two different bands contribute to achieving more realistic results [31]. On the other side, owing to the using 2-tuple linguistic values, intermediate scales resulting from different evaluations of experts can also be taken into consideration. Thus, it can be possible to make more effective evaluations of the expert opinions [32].

The aim of this study is to determine the factors that affect youth unemployment in emerging countries. In this context, firstly, similar studies in the literature have been examined. As a result of these examinations, 3 dimensions and 12 criteria are defined. The fuzzy DEMATEL method is taken into consideration in identifying the importance of these dimensions and criteria. In the analysis process of the study, firstly, interval-valued intuitionistic fuzzy sets are created with the help of 2-tuple linguistic data. After that, relation matrix is generated by considering these fuzzy sets. In the next process, defuzzification process is occurred. In the final stage, the dimensions and criteria are weighted with DEMATEL approach by using defuzzified data sets.

It is possible to mention many originalities that this study adds to the literature. First of all, a new integrated decision-making model with interval-valued intuitionistic fuzzy DEMATEL based on 2-tuple linguistic values is proposed in this study. Because of using this hybrid

implementation firstly, it is thought that this issue has an increasing effect on the originality of the study. In addition to this situation, by using fuzzy DEMATEL methodology, impact relation map can be created between the criteria. Moreover, the weighted driving factors of youth unemployment are provided for emerging economies. This is believed to provide significant guidance to policy makers in these countries.

There are 4 different parts of this study. In the first part, the concepts of unemployment, youth unemployment, interval-valued intuitionistic fuzzy environment and 2-tuple linguistic values are discussed. In the second part of the study, the literature was searched for both the research topic and the methods used. In the third part of the study, the theoretical background of the methods used in the analysis process is given. The fourth part of the study deals with the analysis of emerging countries. In the last section, the results of the analysis and the suggestions developed for these results are given.

II. LITERATURE REVIEW

The literature on the increase of young unemployed people in the country is very rich. The aim of the studies was to determine the main factors in the inclusion of young people in the NEET group. In a significant part of the mentioned studies, it was emphasized that lower income level of the family is the most important factor in this framework. For example, De Lannoy and Mudiriza [33] attempted to identify the reasons that increase the NEET rate in South Africa. As a result, it is concluded that children of low-income families have a higher risk of being included in the NEET group. Moreover, Furlong [34] also used the survey method and highlighted similar issues. In addition, Bynner and Parsons [35] and Noh and Lee [36] focused on the UK and South Korea. In these studies, it is stated that the main reason behind the NEET problem is the income level of the family.

Furthermore, some studies emphasized that the education level of the family is the most important factor in the increase of young unemployed people. In this context, Cabral [37] tried to determine the determinants of NEET in Senegal. In the study using the regression method, it was concluded that the children of families with low educational level had a higher risk of being included in the NEET group. Similarly, Wickremeratne and Dunusinghe [38] conducted an analysis for Sri Lanka and found that low-educated parents could not guide their children correctly. Also, Salvà-Mut *et al.* [39] and Barth *et al.* [40] investigated the NEET problem in different countries and stated that the education level of family members should be increased in order to minimize this problem.

On the other hand, some researchers have emphasized that there is a significant relationship between family ties and NEET. For example, Nudzor [41] examined the NEET problem in the UK. As a result, they stated that when the relationship between the family members was problematic, the unemployment rate of the young people increased and as a result of this, the mentioned young people gave up looking for a job. Pemberton [42] and Tamesberger and Bacher [43] stated that there was a significant correlation between divorce of parents and youth unemployment. A similar study was also conducted by Wong [44] for Australia and Japan. In the related study using panel regression method, it was claimed that problematic family ties are one of the most important factors in the youth becoming NEET.

One of the most important reasons for increasing the NEET problem is that young people receive inappropriate training. In this context, Yates and Payne [45] argue that in order to reduce the NEET problem, young people should be assisted and guided in their educational goals. Furthermore, Walther [46] conducted a similar study for European countries. In this study, it is emphasized that young people became unemployed as a result of participating in inappropriate training. In addition, Reiter and Schlimbach [47] and Avila and Rose [48] reached similar results in their studies. On the other hand, Kraak [49] emphasized that these trainings could not be completed because of preferring wrong trainings by young people.

Some researchers also reported a strong relationship between disease and NEET. For example, Gladwell *et al.* [50], Basta *et al.* [51], Robertson [52], Iyer *et al.* [53] and Goldman-Mellor *et al.* [54] concluded that the presence of physical and mental disorders increases the NEET problem. In addition to the aforementioned studies, Baggio *et al.* [55] and Henderson *et al.* [56] identified that young people using drugs are more likely to be included in the NEET group. Similar to the aforementioned studies, Chen [57] examined the NEET problem in Taiwan. In the study in which the interview method was used, it is argued that the social and emotional deficiencies of the youth are the most important reasons for becoming NEET. Also, Maguire [58] emphasized the importance of the same issue for different country groups.

In addition, the difference in social status has been emphasized in some studies as an important justification for NEET. For example, Ranzani and Rosati [59] tried to identify the causes of the youth unemployment problem in Mexico. Logit method is taken into consideration in the analysis process of the study. In conclusion, there is a strong relationship between gender difference and NEET. Furthermore, Susanli [60] has done similar work for Turkey. According to the results of the analysis, it is found that women have a higher risk of becoming NEET. Moreover, Contini *et al.* [61], Simmons [62], Gaspani [63] and Holte *et al.* [64] found that there is an important relationship between social status and NEET.

An important part of the studies stated that macroeconomic factors have an impact on NEET. In this respect, Mussida and Sciulli [65] determined that economic crises increase the NEET rate. In addition to these studies, Lawy and Wheeler [66] conducted an analysis on England and determined that the country's economic deficiency increases the rate of young unemployed people. On the other hand, Quintano *et al.* [67] emphasized that injustice in regional development plays an important role in this issue.

Moreover, Driouchi and Harkat [68] identified that there is a strong relationship between the general unemployment rate and NEET in the country. In addition to the aforementioned studies, Crisp and Powell [69], Hutchhinson *et al.* [70], Vesan and Lizzi [71], Sergi *et al.* [72] and Serracant [73] argue that political instability in a country increases NEET.

Additionally, fuzzy DEMATEL approach was taken into consideration in the literature with many different purposes. For example, energy industry was analyzed in different ways, such as investment policies [74], performance management [75], renewable energy alternatives [76] and technology selection [77]. Furthermore, manufacturing industry was also examined in some studies with fuzzy DEMATEL methodology [78], [79] and [80]. In addition to these studies, Agarwal and Kant [81], Sennaroğlu and Akıcı [82] and Kaya and Yet [83] also considered this methodology in order to select the best suppliers. On the other side, interval-valued intuitionistic fuzzy environment was also considered especially in recent studies, such as Li et al. [84] and Davoudabadi et al. [85]. Moreover, 2-tuple linguistic evaluations became also popular in this framework [86]–[88].

As can be seen from this literature review, there is a wide literature on youth unemployment. An important part of the work is focused on identifying the issues that cause this problem. However, it was seen that different variables could be considered in the studies. Therefore, there is a need for a new study that will make analysis with a wide set of criteria by conducting a detailed literature review. In this study, a detailed literature review is conducted, and 12 different criteria are defined. Thus, it is thought that this study satisfies this need. Another important point is that in these studies, methods such as survey, regression and logit were generally preferred. Hence, it is obvious that new methods should be considered in the analysis to reach more realistic results. In this framework, a new integrated decision-making model with interval-valued intuitionistic fuzzy DEMATEL based on 2-tuple linguistic values is proposed in this study. Owing to this situation, it is believed that this study makes a contribution to the literature.

III. METHODOLOGY

A. 2-TUPLE LINGUISTIC INFORMATION AND INTERVAL-VALUED INTUITIONISTIC HESITANT FUZZY SETS

The concept of linguistic information is frequently used for evaluating the complex problems of fuzzy-based decision-making approach. In some cases, it is difficult to define the exact evaluations within the provided scales, so the linguistic results are given in 2-tuples (S_i, α) where is $(S_i \in S)$ and $\alpha_i \in [-0.5, 0.5)$. The presentation of 2-tuple linguistic evaluations is given in Figure 1 [89]–[91].

Accordingly, $S = \{s_0, \ldots, s_g\}$ defines the linguistic terms and the 2-tuple term set is $\langle S \rangle = S \times [-0.5, 0.5)$ and the linguistic model based on 2-tuple evaluations are presented as the functions of Δ and Δ^{-1}. Several aggregation functions and the comparison between two 2-tuples. The function is

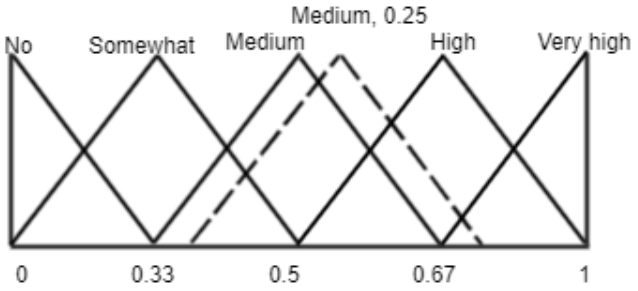

FIGURE 1. 2-tuple linguistic term sets.

$\Delta : [0,g] \to \langle S \rangle$ presented as

$$\Delta(\beta) = (S_i, \alpha), \quad \text{with} \begin{cases} i = round(\beta) \\ \alpha = \beta - i \end{cases} \tag{1}$$

where the term of round assigns to β, Δ is a bijective function, and the integer number $i \in \{0, \ldots, g\}$ closest to β.

$$\Delta^{-1} : \langle S \rangle \to [0, g] \quad \text{and } \Delta^{-1}(S_i, \alpha) = i + \alpha \tag{2}$$

However, linguistic evaluations under the hesitancy have several advantages while the expert team couldn't reach a consensus on their linguistic priorities. Same scores from the decision makers are used only one time for each circumstance [92]. Moreover, membership function is defined as

$$S = \{S_0, S_1, \ldots, S_t\} \tag{3}$$

and the definitions of context-free grammar are given by

$$G_H = (V_N, V_T, I, P) \tag{4}$$

where

$$\begin{aligned} V_N &= \{\langle primary\ term \rangle, \langle composite\ term \rangle, \langle unary\ term \rangle, \\ &\quad \langle binary\ term \rangle, \langle conjunction \rangle\}, \\ V_T &= \{lower\ than, greater\ than, at\ least, at\ most, \\ &\quad between, and, S_0, S_1, \ldots, S_t\}, \quad I \in V_N, \\ P &= \{I ::= \langle primary\ term \rangle | \langle composite\ term \rangle, \\ &\quad \langle composite\ term \rangle ::= \langle composite\ term \rangle \langle primary\ term \rangle \\ &\quad | \langle binary\ relation \rangle \langle primary\ term \rangle \langle conjunction \rangle \\ &\quad \langle primary\ term \rangle, \langle primary\ term \rangle ::= S_0 | S_1 | \ldots | S_t, \\ &\quad \langle unary\ relation \rangle ::= lower\ than | greater\ than \\ &\quad | at\ least | at\ most, \langle binary\ relation \rangle ::= between, \\ &\quad \langle conjunction \rangle ::= and\}. \end{aligned}$$

The evaluations of hesitant linguistic fuzzy sets are illustrated as

$$h_S = \{S_i, S_{i+1}, \ldots, S_j\} \tag{5}$$

Intuitionistic fuzzy set I on U is illustrated as below [93].

$$I = \{\langle \vartheta, \mu_I(\vartheta), n_I(\vartheta) \rangle / \vartheta \epsilon U\} \tag{6}$$

where the $\mu_I(\vartheta) : U \to [0, 1]$ and $n_I(\vartheta) : U \to [0, 1]$ are the membership and non-membership degrees and should be $0 \leq \mu_I(\vartheta) + n_I(\vartheta) \leq 1$.

An intuitionistic hesitant fuzzy set H on U with $h_1(\vartheta)$ and $h_2(\vartheta)$ is given as

$$H = \{\langle \vartheta, h_1(\vartheta), h_2(\vartheta), \vartheta \in U\} \tag{7}$$

where $h_1(\vartheta) : U \to [0, 1]$ and $h_2(\vartheta) : U \to [0, 1]$

$$\mu \geq 0, \quad n \leq 1, \ 0 \leq \mu^+ + n^+ \geq 1, \quad \forall \mu \in h_1(\vartheta), \ n \in h_2(\vartheta) \tag{8}$$

where $\mu^+ \in h_1^+(\vartheta) = \bigcup_{\mu \epsilon h_{1(\vartheta)}} max\{\mu\} \forall \vartheta \in U$ and $n^+ \in h_2^+(\vartheta) = \bigcup_{\mu \epsilon h_{2(\vartheta)}} max\{n\} \forall \vartheta \epsilon U$.

Interval-valued intuitionistic hesitant fuzzy set H in U is

$$\tilde{H} = \left\{\langle \vartheta, h_{\tilde{H}(\vartheta)}\rangle, \vartheta \in U\right\} \tag{9}$$

where $h_{\tilde{H}}(\vartheta)$ is an interval-valued intuitionistic hesitant fuzzy number and $\vartheta = [\mu_\vartheta, n_\vartheta] = \left[\mu_\vartheta^-, \mu_\vartheta^+\right]\left[n_\vartheta^-, n_\vartheta^+\right]$

B. DEMATEL

Decision Making Trial and Evaluation Laboratory (DEMATEL) is introduced by the Institute of Geneva Battelle Memorial to construct a compherensive impact and relation maps among the factors as well as the weights of them [94]. The computation procedure of the method is presented as [95], [96].

Initially, direct relation matrix of factors is constructed with k number of expert opinions by the formula (10)

$$A_k = \begin{bmatrix} 0 & \cdots & a_{1nk} \\ \vdots & \ddots & \vdots \\ a_{n1k} & \cdots & 0 \end{bmatrix} \tag{10}$$

At the following process, normalization procedure is applied by the formula (11)

$$B = \left[b_{ij}\right]_{nxn} = \frac{A}{max \sum_{j=1}^{n} a_{ij}} \tag{11}$$

where b_{ij} is between 0 and 1.

In the third step, total relation matrix is calculated with the equation (12)

$$C = \left[c_{ij}\right]_{nxn} = B(I - B)^{-1} \tag{12}$$

where C is the total relation matrix and I is the identity matrix.

The values of (D + E) defining the prominence and the values of (D-E) that are the cause-effect are computed by using the formulas (13) and (14).

$$D = \left[d_{ij}\right]_{nx1} = \left[\sum_{j=1}^{n} c_{ij_{ij}}\right]_{nx1} \tag{13}$$

$$E = \left[e_{ij}\right]_{1xn} = \left[\sum_{j=1}^{n} c_{ij_{ij}}\right]_{1xn} \tag{14}$$

To understand the impact-relation directions of factors, threshold value of matrix is calculated and the higher values of pairwise comparison are also defined as there is an influence among the criteria. The value is obtained by the formula (15)

$$a = \frac{\sum_{j=1}^{n} \sum_{i=1}^{n} c_{ij}}{n^2} \tag{15}$$

IV. ANALYSIS

In this analysis, an integrated model with three stages is proposed by using 2-tuple linguistic information, interval-valued intuitionistic fuzzy sets, and DEMATEL. So, it is aimed to measure the impact and relation map among the criteria and dimensions of youth unemployed more accurately with this proposed decision-making approach.

Figure 2 shows the flowchart of integrated model in detail.

According to the figure, the proposed model is constructed with the three stages.

Firstly, the problem of multi-criteria decision making analysis is defined and set of dimensions and criteria is provided with the supported literature. And then, the context-free grammar evaluations for the dimensions and criteria are collected from the decision makers to define the linguistic boundaries of each comparison.

Secondly, the optimistic and pessimistic values of factors are determined and the collective results based on 2-tuple values are constructed for converting the values into the interval-valued intuitionistic fuzzy numbers.

Finally, the impact and relationship degrees between the dimensions and criteria are computed by using DEMATEL. For that, the defuzzified values are calculated and total relation matrices are constructed to weight the each dimension and criterion.

The steps of integrated decision-making approach are examined as follows

Define the problems of multi-criteria decision-making model: the proposed dimensions and criteria of youth unemployed are presented with the supported literature. The factors are represented in Table 1.

Provide linguistic evaluations for the criteria and alternatives: The evaluations are obtained from 3 decision makers who are experts in the employment policies of emerging economies with at least ten-year experiences. 5-point linguistic scales are used for measuring the relationship between the criteria and dimensions and linguistic scales and evaluation numbers are given in Table 2.

However, as a novelty of this study, the context-free grammar definitions such as ''lower than'', ''at least'', ''greater than'', and ''between'' are permitted to measure the extreme priorities among the factors. Thus, it is aimed to understand the flexible evaluations of decision makers more efficiently. The results are illustrated in Table 3 and 6 respectively.

Provide symbolic translations and aggregated values: The extreme values of hesitant linguistic evaluations are determined by constructing the linguistic boundaries of each comparison among the criteria. Table 7 shows the extreme linguistic results of relation matrix for the dimensions.

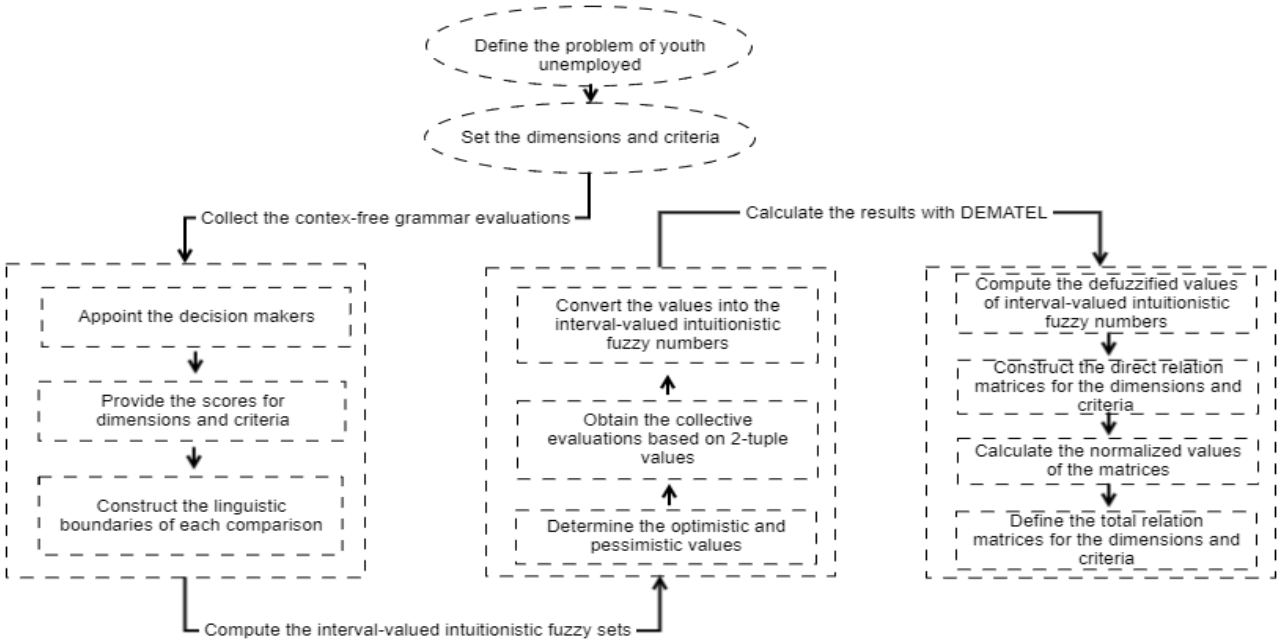

FIGURE 2. The flowchart of proposed model.

TABLE 1. Selected dimensions and criteria of NEET youth.

Dimensions	Criteria	Supported Literature
Family (Dimension 1)	Uneducated parent (Criterion 1)	[37], [38], [39]
	Low income of family (Criterion 2)	[33], [34], [35]
	Poor family support (Criterion 3)	[41], [42]
	Divorced or separate living of parents (Criterion 4)	[43], [44]
Individual (Dimension 2)	Lack of education (Criterion 5)	[45], [46], [47]
	Drug addiction (Criterion 6)	[52], [53], [54]
	Mental disorder (Criterion 7)	[55], [56]
	Physical disability (Criterion 8)	[65], [66]
Environment (Dimension 3)	Economic crisis (Criterion 9)	[39], [65]
	Economic and social inequalities (Criterion 10)	[59], [60], [61]
	Insufficient education conditions (Criterion 11)	[67], [68]
	Inadequacy of infrastructure for investment (Criterion 12)	[69], [70], [71]

TABLE 2. Relation scales for criteria.

Linguistic Scales	Evaluation Numbers
No influence (n)	1
somewhat influence (s)	2
medium influence (m)	3
high influence (h)	4
very high influence (vh)	5

Source: Adapted from Awasthi and Grzybowska [97]

Similarly, the extreme values for the criteria of each dimension are presented in appendix A-C.

Construct the optimistic and pessimistic values: the evaluations from the decision makers are converted into the 2-tuple linguistic evaluations with the optimistic and pessimistic boundaries. Table 8 shows the collective linguistic evaluations based on 2-tuple values for the dimensions. The evaluations for the criteria of each dimension are given in appendix D-F respectively.

Convert the values into the interval-valued intuitionistic fuzzy sets: Collective optimistic and pessimistic values of 2-tuple linguistic evaluations are converted into the interval-valued intuitionistic fuzzy numbers by considering the limits of 2-tuple linguistic values in five-point scales. The results are represented in Table 9. The results of criteria are given in appendix G-I.

Calculate the impact and relation degrees of dimensions and criteria: The evaluations based on interval-valued intuitionistic fuzzy sets are defuzzified by using accuracy function with the formula (16)

$$H(A) = \frac{a+b+c+d}{2} \tag{16}$$

where $H(A) \in [0, 1]$, $[a, b]$ and $[c, d]$ are the elements of interval-valued intuitionistic fuzzy number [98].

Defuzzified values are used for constructing the direct relation matrix and the computation procedure of DEMATEL is applied for measuring the influence degrees and directions of each dimension and criterion. Table 10-12 define the computation results of DEMATEL for the dimensions with the formulas (10)-(15) respectively. The criteria results are also illustrated in appendix J-R.

The values of (D + E) are used for weighting the criteria and dimensions. In table 12, dimension 3 has the most importance among the dimension set while dimension 1 has

TABLE 3. Context-free grammar evaluations for the dimensions.

	D1			D2			D3		
	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3
D1				lower than "m"	between "s" and "h"	between "m" and "h"	at least "m"	at least "h"	at most "m"
D2	at most "m"	at least "m"	between "s" and "h"				greater than "s"	at least "m"	at least "m"
D3	at most "h"	at least "m"	between "h" and "vh"	greater than "h"	at most "h"	at most "h"			

TABLE 4. Context-free grammar evaluations for the criteria of dimension 1.

	C1			C2			C3			C4		
	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3
C1				lower than "m"	greater than "h"	at most "m"	at least "s"	at least "m"	"s"	at least "s"	alt least "s"	at most "m"
C2	at most "h"	between "s" and "h"	"vh"				"s"	"m"	at most "m"	"s"	at least "m"	"s"
C3	"s"	at most "h"	greater than "s"	between "m" and "vh"	at least "m"	at least "s"				greater than "s"	"s"	at most "m"
C4	"s"	at least "s"	lower than "h"	at most "h"	at least "h"	at most "h"	"m"	lower than "h"	greater than "h"			

TABLE 5. Context-free grammar evaluations for the criteria of dimension 2.

	C5			C6			C7			C8		
	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3
C5				greater than "m"	at most "m"	"h"	at least "m"	at least "h"	"m"	between "s" and "h"	greater than "m"	at most "m"
C6	at least "m"	at least "m"	greater than "m"				greater than "m"	at least "h"	"m"	at most "m"	greater than "h"	"h"
C7	at least "h"	at most "h"	at most "m"	between "s" and "vh"	at least "s"	"vh"				greater than "m"	at least "m"	at most "h"
C8	greater than "m"	greater than "m"	lower than "m"	"m"	at least "m"	at most "h"	"h"	lower than "h"	greater than "m"			

TABLE 6. Context-free grammar evaluations for the criteria of dimension 3.

	C9			C10			C11			C12		
	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3
C9				greater than "h"	lower than "h"	between "m" and "h"	between "s" and "vh"	at most "m"	lower than "h"	between "s" and "h"	at most "m"	at most "m"
C10	"h"	greater than "h"	at least "h"				between "h" and "vh"	at least "m"	at least "m"	at most "h"	greater than "m"	at least "h"
C11	"vh"	greater than "m"	at most "h"	lower than "h"	at least "m"	at least "vh"				greater than "s"	lower than "h"	lower than "h"
C12	"m"	at least "m"	at least "h"	lower than "h"	lower than "vh"	at most "h"	between "m" and "vh"	lower than "m"	lower than "h"			

relatively the weakest weight and also, the values of (D-E) give an information on the influence among the dimension set. Accordingly, dimension 2 is the most influencing dimension as dimension 1 is the most influenced factor in the dimensions of youth unemployed.

TABLE 7. Boundaries of hesitant linguistic term sets for the dimensions.

	D1			D2			D3		
	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3
D1				$[n,s]$	$[s,h]$	$[n,m]$	$[m,vh]$	$[h,vh]$	$[n,m]$
D2	$[n,m]$	$[m,vh]$	$[s,h]$				$[m,vh]$	$[m,vh]$	$[m,vh]$
D3	$[n,h]$	$[m,vh]$	$[h,vh]$	$[vh,vh]$	$[n,h]$	$[vh,vh]$			

TABLE 8. 2-tuple values of collective linguistic evaluations for the dimensions.

	D1		D2		D3	
	Optimistic	Pessimistic	Optimistic	Pessimistic	Optimistic	Pessimistic
D1			(s,0)	(n,0.33)	(m,0.33)	(s,-0.33)
D2	(m,0)	(n,0)			(v,0)	(s,0)
D3	(v,-0.33)	(s,-0.33)	(v,-0.33)	(m,-0.33)		

TABLE 9. Interval-valued intuitionistic fuzzy sets for the dimensions.

	D1	D2	D3
D1		((0.20,0.40), (0.05,0.07))	((0.60,0.67), (0.20,0.33))
D2	((0.40,0.60), (0.60,0.10))		((0.60,0.80), (0.20,0.40))
D3	((0.60,0.73), (0.20,0.33))	((0.60,0.73), (0.40,0.53))	

TABLE 10. Direct relation matrix for dimensions.

	D1	D2	D3
D1	0.00	0.36	0.90
D2	0.65	0.00	1.00
D3	0.93	1.13	0.00

However, the averaged values of total relation matrix are defined as threshold value and higher values than threshold indicate that there is an influence on the other criterion. Figure 3-6 illustrate the impact-relation maps among the criteria and dimensions.

While analyzing these figures, it is concluded that family (dimension 1) is the most affected dimension. This situation indicates that economic and social problems in countries and factors such as drug use affect family ties negatively. In addition to this condition, by considering the impact relationship for the criteria under the dimension of family (dimension 1), it is also determined that weak family ties have an impact on all other criteria. On the other side, regarding the causality relationship between the criteria under the dimension of individual (dimension 2), drug addiction is the most influential variable. Moreover, when environmental factors are examined, it is clear that all factors such as lack of infrastructure, economic and social inequalities and inadequate education cause economic crises. After analyzing the impact relation map of the dimensions and criteria, the weights of them are calculated. The details of this calculation are demonstrated on Table 13.

Table 13 indicates that environment (dimension 3) is the most important dimension that affects youth unemployment in emerging economies. In addition, individual (dimension 2) has the second highest importance whereas family

TABLE 11. Normalized direct relation matrix for dimensions.

	D1	D2	D3
D1	0.00	0.17	0.44
D2	0.31	0.00	0.48
D3	0.45	0.55	0.00

TABLE 12. Total relation matrix and values of D and E for dimensions.

	D1	D2	D3	D	E	D+E	D-E
D1	0.98	1.11	1.40	3.50	4.11	7.60	-0.61
D2	1.44	1.17	1.68	4.28	3.97	8.26	0.31
D3	1.68	1.69	1.55	4.93	4.63	9.56	0.30

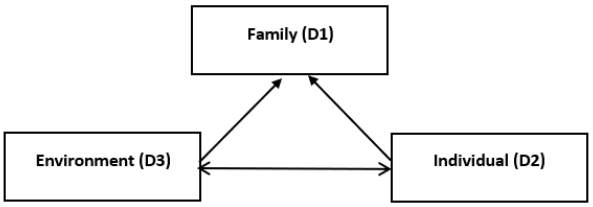

FIGURE 3. Impact-relation map of the dimensions.

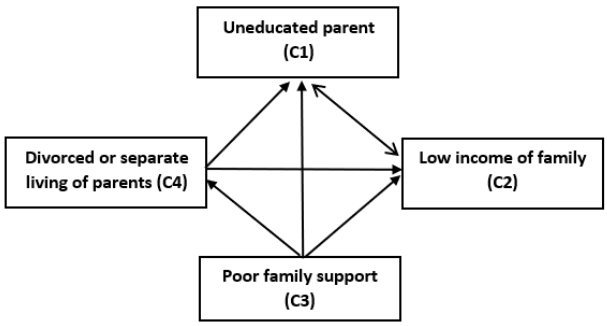

FIGURE 4. Impact-relation map of the criteria of dimension 1.

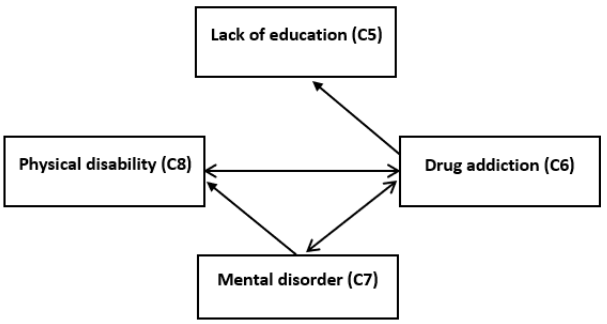

FIGURE 5. Impact-relation map of the criteria of dimension 2.

(dimension 1) takes place on the last rank. On the other hand, it is also concluded that economic and social inequalities (criterion 10) is the most significant criterion which leads to youth unemployment in these countries. This result is parallel to many studies in the literature [59]–[61]. Furthermore, it is also identified that that economic crisis (criterion 9) and

TABLE 13. Global and local weights of criteria and dimensions.

Dimensions	Weights	Criteria	Local Weights	Global Weights
Family (Dimension 1)	0.299	Uneducated parent (Criterion 1)	0.239	0.072
		Low income of family (Criterion 2)	0.272	0.081
		Poor family support (Criterion 3)	0.248	0.074
		Divorced or separate living of parents (Criterion 4)	0.241	0.072
Individual (Dimension 2)	0.325	Lack of education (Criterion 5)	0.215	0.070
		Drug addiction (Criterion 6)	0.271	0.088
		Mental disorder (Criterion 7)	0.258	0.084
		Physical disability (Criterion 8)	0.256	0.083
Environment (Dimension 3)	0.376	Economic crisis (Criterion 9)	0.254	0.096
		Economic and social inequalities (Criterion 10)	0.280	0.105
		Insufficient education conditions (Criterion 11)	0.248	0.093
		Inadequacy of infrastructure for investment (Criterion 12)	0.218	0.082

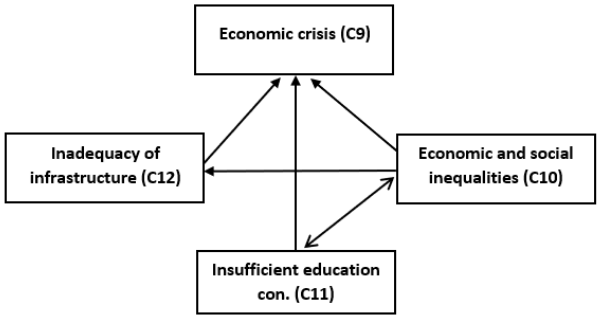

FIGURE 6. Impact-relation map of the criteria of dimension 3.

insufficient education conditions (criterion 11) also play a crucial role for NEET in emerging economies. In the literature, Mussida and Sciulli [65], Quintano et al. [67] and Driouchi and Harkat [68] also underlined the importance of these factors to minimize youth unemployment problem.

V. DISCUSSION AND CONCLUSION

In this study, it is aimed to determine the issues affecting youth unemployment in emerging countries. In this context, firstly, similar studies in the literature are examined in detail. As a result, 3 dimensions and 12 different criteria that could affect youth unemployment are identified. In the first phase of the analysis process, interval-valued intuitionistic fuzzy sets are created by using 2-tuple linguistic data. In the next step, defuzzification process is occurred. Consequently, fuzzy DEMATEL approach is considered to understand the significance levels of these dimensions and criteria.

As a result, it is defined that family is the most affected dimension. Additionally, weak family ties have an impact on all other criteria. Also, it is also defined that drug addiction is the most influential variable. Moreover, when environmental factors are examined, it is clear that all factors such as lack of infrastructure, economic and social inequalities and inadequate education cause economic crises.

In addition to them, it is also concluded that environment is the most important dimension that affects youth unemployment in emerging economies. On the other side, economic and social inequalities are found as the most significant criterion. Similarly, economic crisis and insufficient education conditions have also important role for youth unemployment problem in emerging countries as a result of fuzzy DEMATEL analysis.

The findings state that it would be necessary for developing countries to improve their educational conditions to minimize this problem and identify the labor needs in the industry. Hence, it is thought that states should cooperate with companies in the industry. With the help of this situation, education system will be designed according to the needs in the market. Therefore, young people will be able to find work faster after completing their education. This situation has an important contribution to the sustainability of the social security systems in the countries. Supportedly, Quintano et al. [67] tried to identify the main indicators of youth unemployment in Italy. They underlined the importance of well-designed education system to minimize this problem. Driouchi and Harkat [68] also focused on the importance of this situation to overcome unemployment problem for Arab countries.

Moreover, it would be a better idea to make appropriate investments so that citizens should have access to some basic needs such as hospitals and education. In this context, it is believed that investments within the country should be made according to the needs of different regions. In this way, the differences between the regions in the country can be eliminated and this situation could play an important role in reducing social inequality. On the other hand, thanks to a fair tax policy and investments in different regions, economic inequality in countries can be reduced. Hence, it could be easier for young people to find a job. Accordingly, Ranzani and Rosati [59] made a study related to NEET problem in

TABLE 14. Boundaries of hesitant linguistic term sets for the criteria of dimension 1.

	C1			C2			C3			C4		
	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3
C1				$[n,s]$	$[vh,vh]$	$[n,m]$	$[n,s]$	$[m,vh]$	$[s,s]$	$[n,s]$	$[s,vh]$	$[n,m]$
C2	$[n,h]$	$[s,h]$	$[vh,vh]$				$[s,s]$	$[m,m]$	$[n,m]$	$[s,s]$	$[m,vh]$	$[s,s]$
C3	$[s,s]$	$[n,h]$	$[m,vh]$	$[m,vh]$	$[m,vh]$	$[s,vh]$				$[m,vh]$	$[s,s]$	$[n,m]$
C4	$[s,s]$	$[s,h]$	$[n,m]$	$[n,h]$	$[h,vh]$	$[n,h]$	$[m,m]$	$[n,m]$	$[vh,vh]$			

TABLE 15. Boundaries of hesitant linguistic term sets for the criteria of dimension 2.

	C5			C6			C7			C8		
	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3
C5				$[n,s]$	$[n,m]$	$[h,h]$	$[n,s]$	$[h,vh]$	$[m,m]$	$[n,s]$	$[h,vh]$	$[m,m]$
C6	$[n,h]$	$[m,vh]$	$[h,vh]$				$[s,s]$	$[h,vh]$	$[m,m]$	$[s,s]$	$[vh,vh]$	$[h,h]$
C7	$[s,s]$	$[n,h]$	$[n,m]$	$[m,vh]$	$[s,vh]$	$[vh,vh]$				$[m,vh]$	$[m,vh]$	$[n,h]$
C8	$[s,s]$	$[h,vh]$	$[n,s]$	$[n,h]$	$[m,vh]$	$[n,h]$	$[m,m]$	$[n,m]$	$[h,vh]$			

TABLE 16. Boundaries of hesitant linguistic term sets for the criteria of dimension 3.

	C9			C10			C11			C12		
	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3
C9				$[vh,vh]$	$[n,m]$	$[h,h]$	$[s,vh]$	$[n,m]$	$[m,m]$	$[s,h]$	$[n,m]$	$[m,m]$
C10	$[h,h]$	$[vh,vh]$	$[h,vh]$				$[h,vh]$	$[m,vh]$	$[m,m]$	$[n,h]$	$[h,vh]$	$[h,h]$
C11	$[vh,vh]$	$[h,vh]$	$[n,m]$	$[n,m]$	$[m,vh]$	$[vh,vh]$				$[m,vh]$	$[n,m]$	$[n,h]$
C12	$[m,m]$	$[m,vh]$	$[n,s]$	$[m,vh]$	$[n,h]$	$[n,h]$	$[m,vh]$	$[n,s]$	$[h,vh]$			

TABLE 17. 2-tuple values of collective linguistic evaluations for the criteria of dimension 1.

	C1		C2		C3		C4	
	Optimistic	Pessimistic	Optimistic	Pessimistic	Optimistic	Pessimistic	Optimistic	Pessimistic
C1			(s,0.33)	(n,0.33)	(s,0)	(n,0)	(s,0.33)	(n,0.33)
C2	(m,0.33)	(s,-0.33)			(s,-0.33)	(n,0)	(s,0)	(n,0.33)
C3	(m,-0.33)	(n,0)	(v,0)	(s,-0.33)			(s,0.33)	(n,0)
C4	(s,0)	(n,-0.33)	(m,0.33)	(n,0)	(m,-0.33)	(s,0)		

Mexico and identified that economic and social inequality can be prevented to minimize this problem. In addition, Susanli [60] and Contini et al. [61] are other studies which reached the similar conclusion.

The most important limitation of this study is that it focuses only on emerging countries. In a new study, different countries or groups of countries may also be included in the study. However, the different methods of multi-criteria decision making approach such as interval type-2 fuzzy sets could be also used comparatively for the further studies.

APPENDIXES

APPENDIX A

See Table 14.

APPENDIX B

See Table 15.

APPENDIX C

See Table 16.

APPENDIX D

See Table 17.

APPENDIX E

See Table 18.

TABLE 18. 2-tuple values of collective linguistic evaluations for the criteria of dimension 2.

	C5		C6		C7		C8	
	Optimistic	Pessimistic	Optimistic	Pessimistic	Optimistic	Pessimistic	Optimistic	Pessimistic
C5			(s,0)	(n,0)	(s,0.33)	(s,-0.33)	(s,0.33)	(s,-0.33)
C6	(v,-0.33)	(s,-0.33)			(s,0.33)	(s,0)	(m,-0.33)	(m,-0.33)
C7	(s,0)	(n,0.33)	(v,0)	(s,0.33)			(v,-0.33)	(n,0.33)
C8	(s,0)	(n,0.33)	(m,0.33)	(n,-0.33)	(m,-0.33)	(s,-0.33)		

TABLE 19. 2-tuple values of collective linguistic evaluations for the criteria of dimension 3.

	C9		C10		C11		C12	
	Optimistic	Pessimistic	Optimistic	Pessimistic	Optimistic	Pessimistic	Optimistic	Pessimistic
C9			(m,0)	(s,0.33)	(m,-0.33)	(n,0)	(s,0.33)	(n,0)
C10	(v,-0.33)	(m,0.33)			(m,0.33)	(s,0.33)	(m,0.33)	(s,0)
C11	(m,0.33)	(s,0.33)	(m,0.33)	(s,0)			(m,0)	(n,-0.33)
C12	(s,0.33)	(n,0.33)	(m,0.33)	(n,-0.33)	(m,0)	(s,-0.33)		

TABLE 20. Interval-valued intuitionistic fuzzy sets for the criteria of dimension 1.

	C1	C2	C3	C4
C1		((0.40,0.47),(0.20,0.27))	((0.20,0.40),(0.10,0.20))	((0.40,0.47),(0.05,0.07))
C2	((0.60,0.67),(0.20,0.33))		((0.20,0.33),(0.10,0.20))	((0.20,0.40),(0.20,0.27))
C3	((0.40,0.53),(0.10,0.20))	((0.60,0.80),(0.10,0.20))		((0.40,0.47),(0.10,0.20))
C4	((0.20,0.40),(0.10,0.13))	((0.60,0.67),(0.10,0.20))	((0.40,0.53),(0.20,0.40))	

TABLE 21. Interval-valued intuitionistic fuzzy sets for the criteria of dimension 2.

	C5	C6	C7	C8
C5		((0.20,0.40),(0.10,0.20))	((0.40,0.47),(0.20,0.33))	((0.40,0.47),(0.20,0.33))
C6	((0.60,0.73),(0.20,0.33))		((0.40,0.47),(0.20,0.40))	((0.40,0.53),(0.40,0.53))
C7	((0.20,0.40),(0.05,0.07)	((0.60,0.80),(0.40,0.47))		((0.60,0.73),(0.20,0.27))
C8	((0.20,0.40),(0.20,0.27))	((0.60,0.67),(0.10,0.13))	((0.40,0.53),(0.20,0.33))	

TABLE 22. Interval-valued intuitionistic fuzzy sets for the criteria of dimension 3.

	C9	C10	C11	C12
C9		((0.40,0.60),(0.40,0.47))	((0.40,0.53),(0.10,0.20))	((0.40,0.47),(0.10,0.20))
C10	((0.60,0.73),(0.60,0.67))		((0.60,0.67),(0.40,0.47))	((0.60,0.67),(0.20,0.40))
C11	((0.60,0.67),(0.40,0.47)	((0.60,0.67),(0.20,0.40))		((0.40,0.60),(0.10,0.13))
C12	((0.40,0.47),(0.20,0.27))	((0.60,0.67),(0.10,0.13))	((0.40,0.60),(0.20,0.33))	

APPENDIX F
See Table 19.

APPENDIX G
See Table 20.

APPENDIX H
See Table 21.

APPENDIX I
See Table 22.

APPENDIX J
See Table 23.

APPENDIX K
See Table 24.

TABLE 23. Direct relation matrix for the criteria of dimension 1.

	C1	C2	C3	C4
C1	0.00	0.67	0.45	0.49
C2	0.90	0.00	0.42	0.53
C3	0.62	1.00	0.00	0.58
C4	0.42	0.83	0.77	0.00

TABLE 24. Direct relation matrix for the criteria of dimension 2.

	C5	C6	C7	C8
C5	0.00	0.45	0.70	0.70
C6	0.93	0.00	0.73	0.93
C7	0.36	1.13	0.00	0.90
C8	0.53	0.75	0.73	0.00

TABLE 25. Direct relation matrix for the criteria of dimension 3.

	C9	C10	C11	C12
C9	0.00	0.93	0.62	0.58
C10	1.30	0.00	1.07	0.93
C11	1.07	0.93	0.00	0.62
C12	0.67	0.75	0.77	0.00

TABLE 26. Normalized direct relation matrix for the criteria of dimension 1.

	C1	C2	C3	C4
C1	0.00	0.30	0.20	0.22
C2	0.41	0.00	0.19	0.24
C3	0.28	0.45	0.00	0.27
C4	0.19	0.38	0.35	0.00

TABLE 27. Normalized direct relation matrix for the criteria of dimension 2.

	C5	C6	C7	C8
C5	0.00	0.17	0.27	0.27
C6	0.36	0.00	0.28	0.36
C7	0.14	0.44	0.00	0.35
C8	0.21	0.29	0.28	0.00

TABLE 28. Normalized direct relation matrix for the criteria of dimension 3.

	C9	C10	C11	C12
C9	0.00	0.28	0.19	0.18
C10	0.39	0.00	0.32	0.28
C11	0.32	0.28	0.00	0.19
C12	0.20	0.23	0.23	0.00

APPENDIX L

See Table 25.

APPENDIX M

See Table 26.

APPENDIX N

See Table 27.

APPENDIX O

See Table 28.

TABLE 29. Total relation matrix and values of D and E for the criteria of dimension 1.

	C1	C2	C3	C4	D	E	D+E	D-E
C1	1.30	1.74	1.24	1.26	5.54	6.65	12.19	-1.11
C2	1.72	1.65	1.34	1.38	6.09	7.77	13.86	-1.67
C3	1.89	2.25	1.37	1.60	7.11	5.51	12.62	1.60
C4	1.75	2.12	1.57	1.32	6.75	5.56	12.31	1.19

TABLE 30. Total relation matrix and values of D and E for the criteria of dimension 2.

	C5	C6	C7	C8	D	E	D+E	D-E
C5	0.96	1.34	1.32	1.46	5.08	5.08	10.16	0.00
C6	1.53	1.54	1.66	1.90	6.63	6.21	12.83	0.42
C7	1.36	1.82	1.40	1.85	6.43	5.81	12.23	0.62
C8	1.23	1.52	1.43	1.37	5.54	6.58	12.12	-1.04

TABLE 31. Total relation matrix and values of D and E for the criteria of dimension 3.

	C9	C10	C11	C12	D	E	D+E	D-E
C9	0.72	0.86	0.76	0.69	3.03	3.98	7.02	-0.95
C10	1.28	0.88	1.07	0.96	4.20	3.53	7.73	0.66
C11	1.09	0.96	0.70	0.78	3.53	3.32	6.85	0.21
C12	0.89	0.83	0.79	0.54	3.05	2.97	6.02	0.08

APPENDIX P

See Table 29.

APPENDIX Q

See Table 30.

APPENDIX R

See Table 31.

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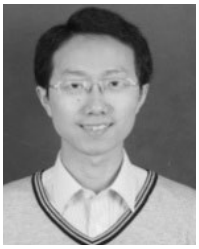

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