Group Decision Making by Signless Laplacian Energy of an Intuitionistic Fuzzy Graphs

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Abstract: Group decision-making shows a critical job while designating with dynamic issues with the quick development of society. The first assurance of this paper is to show the sensibility of some Group decision-making on the Signlesslaplacian energy of an intuitionistic fuzzy diagrams. we present numerical models, including Alliance Partner Selection of an Automobile Company , flexibly chain associations in the construction business and Evaluation of the schemes for development of agriculture and farmers's welfare to light up the introductions of our arranged ideas in result making to rank the best one.

Index Terms: Intuitionistic fuzzy graphs (IFGs); Signlesslaplacian energy; Alliance Partner Selection of a Automobile Company; flexibly chain associations in the construction business; schemes for development of agriculture and farmers's welfare.

1. INTRODUCTION

Group decision–making is one among the pre-owned apparatus in person exercises, which determined the ideal option from a given limited arrangement of choices utilizing the information given by gathering of chiefs or experts.Group dynamic assumes a urgent job when dealing with choosing issues with the fast advancement of society. Past many scholars have examined the methodologies for Group decision–making bolstered different methods. Be that as it may in order to mirror the connections among the choices we'd prefer to shape pair shrewd comparisons for all designations inside the procedure of dynamic. Inclination connection might be an amazing quantitative choice method that underpins specialists in communicating their inclinations over the given other options. For a lot of options $Z = \{z_1, z_2, ..., z_n\}$, the specialists think about each pair of options and develop inclination relations of each component in the inclination relations is intuitionistic fuzzy number, at that point the idea of an Intuitionistic inclination relationship(IIR) can be characterized as follows

Definition:-A Intuitionistic fuzzy inclination retain on the set $Z = \{z_1, z_2, ..., z_n\}$is represented by a matrix $M = [\gamma_{ik}]_{n \times n}$, where $\gamma_{ik} = \langle z_j z_k, T(z_j z_k), F(z_i z_k) \rangle$, $\forall$ j,k=1,2,…,n. For convenience, let $\gamma_{jk} = \langle T_{jk}, F_{jk} \rangle$. where T_{jk} indicates the degree to which the object z_j is prepared to the object z_k and F_{jk} is prepared as membership degree with the conditions

$$T_{jk}, F_{jk} \in [0,1] \; T_{jk} = F_{jk} \; T_{jj} = F_{jj} = 0 \; \textit{for all } j,k = 1,2,,...,n$$

A group decision-making problem issue concerning the "Alliance partner selection of a Auto mobile company" is settled for example the relevance of the proposed ideas of Signlesslaplacian energy of an intuitionistic fuzzy chart in sensible situation.

2. SIGNIFICANT RESULTS

2.1 Alliance Partner Selection of a Automobile Company

Maruti Suzuki is that the biggest automobile manufacturer in India. It proposals an upscale assortment of economic counting product engineering solutions, and associated to Automobile products and stage and facilities. To progress the operation and attractiveness proficiency within the broad market, Maruti Suzuki strategies to found a planned alliance with a worldwide corporation. After plentiful discussions, five transnational company would really like to found a planned association with Maruti Suzuki ; they're Tata Motors(a1) , Mahindra & Mahindra(a2) , Hyundai India(a3) , Bajaj Auto Limited(a4) and Honda Motor Company(a5) . To select the wanted planned alliance partner, three experts e_i $(i = 1,2,3)$ are invited to subsidize within the decision analysis, who originate from Manufacturing engineering department, Finance & cost control department and therefore the Sales and Marketing department of Maruti Suzuki respectively. Established on their involvements, the specialists compare each few replacements and provides separate judgements using the subsequent IFPRS $M_i = \left[\gamma_{jk}^{(i)}\right]_{5\times5} (i = 1, 2, 3)$.

The IFGS D_i corresponding to IFPRS $M_i\,(i = 1, 2, 3)$ given in table 1-3, are shown in figure.

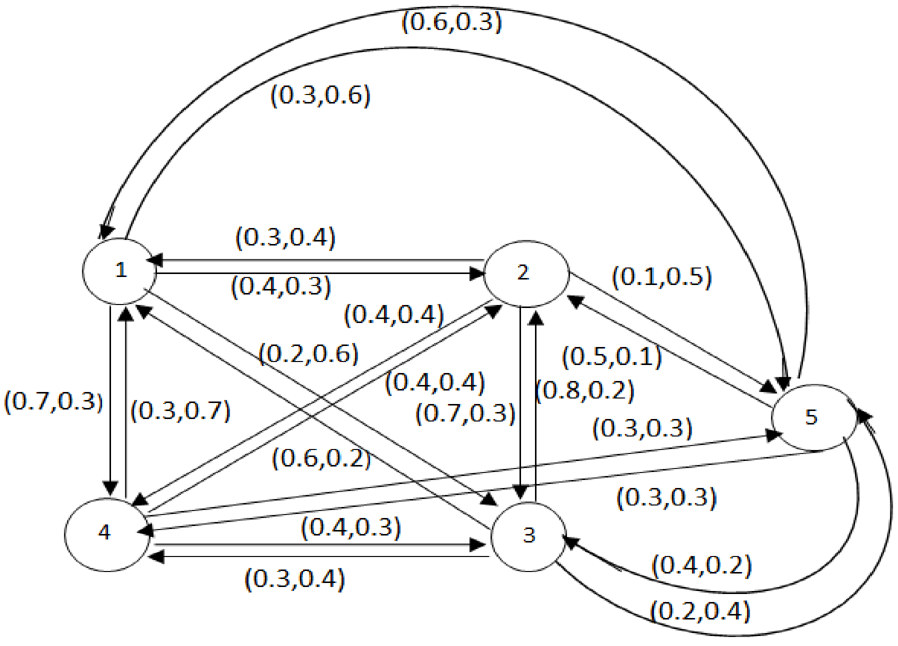


Table 1: IFIR of expert from Manufacturing engineering department

M_1	a_1	a_2	a_3	a_4	a_5
a_1	(0,0)	(0.4,0.3)	(0.2,0.6)	(0.7,0.3)	(0.3,0.6)
a_2	(0.3,0.4)	(0,0)	(0.7,0.3)	(0.4,0.4)	(0.1,0.5)
a_3	(0.6,0.2)	(0.8,0.2)	(0,0)	(0.3,0.4)	(0.2,0.4)
a_4	(0.3,0.7)	(0.4,0.4)	(0.4,0.3)	(0,0)	(0.3,0.3)
a_5	(0.6,0.3)	(0.5,0.1)	(0.4,0.2)	(0.3,0.3)	(0,0)

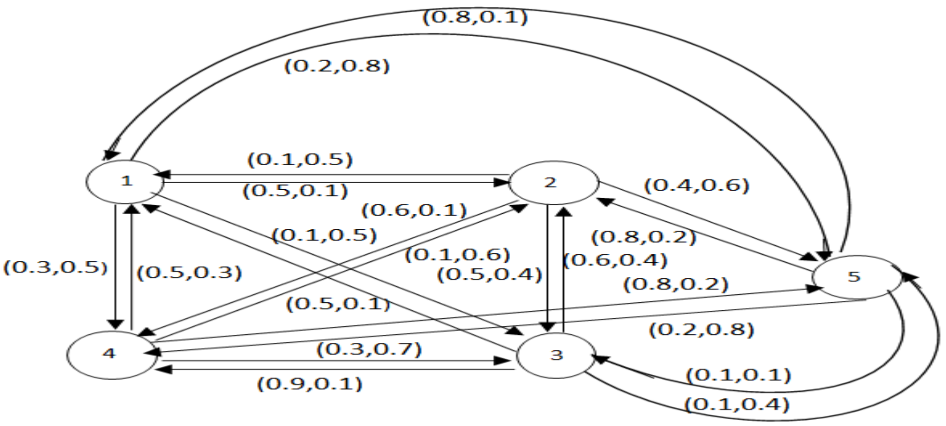


Table 2: IFIR of expert from Finance & cost control department

M_2	a_1	a_2	a_3	a_4	a_5

a_1	(0,0)	(0.5,0.1)	(0.1,0.5)	(0.3,0.5)	(0.2,0.8)
a_2	(0.1,0.5)	(0,0)	(0.5,0.4)	(0.6,0.1)	(0.4,0.6)
a_3	(0.5,0.1)	(0.6,0.4)	(0,0)	(0.9,0.1)	(0.1,0.4)
a_4	(0.5,0.3)	(0.1,0.6)	(0.3,0.7)	(0,0)	(0.8,0.2)
a_5	(0.8,0.1)	(0.8,0.2)	(0.1,0.1)	(0.2,0.8)	(0,0)

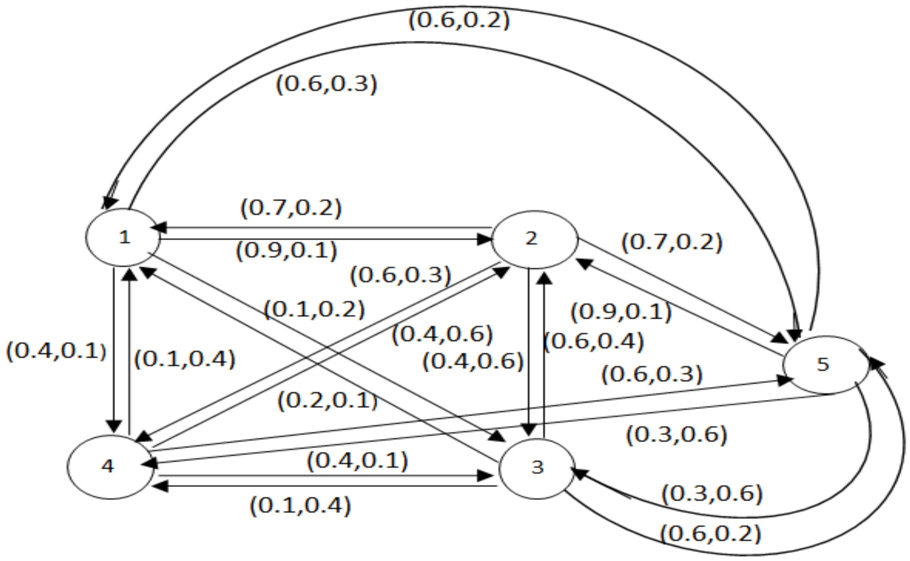


Table 3: IFIR of expert from Sales and Marketing department

M_3	a_1	a_2	a_3	a_4	a_5
a_1	(0,0)	(0.9,0.1)	(0.1,0.2)	(0.4,0.1)	(0.6,0.3)
a_2	(0.7,0.2)	(0,0)	(0.4,0.6)	(0.6,0.3)	(0.7,0.2)
a_3	(0.2,0.1)	(0.6,0.4)	(0,0)	(0.1,0.4)	(0.6,0.2)
a_4	(0.1,0.4)	(0.4,0.6)	(0.4,0.1)	(0,0)	(0.6,0.3)
a_5	(0.6,0.2)	(0.9,0.1)	(0.3,0.6)	(0.3,0.6)	(0,0)

The components of the Signlesslaplacian frameworks of the IFGS $SL(D_i) = M_i^{SL} \left(i = 1,2,3\right)$ appeared in figure 1 are given in tables 4-6

Table 4: Elements of the Signlesslaplacian matrix of the IFIR D_1

M_1^{SL}	a_1	a_2	a_3	a_4	a_5
a_1	(1.6,1.8)	(0.4,0.3)	(0.2,0.6)	(0.7,0.3)	(0.3,0.6)

a_2	(0.3,0.4)	(1.5,1.6)	(0.7,0.3)	(0.4,0.4)	(0.1,0.5)
a_3	(0.6,0.2)	(0.8,0.2)	(1.9,1.2)	(0.3,0.4)	(0.2,0.4)
a_4	(0.3,0.7)	(0.4,0.4)	(0.4,0.3)	(1.4,1.7)	(0.3,0.3)
a_5	(0.6,0.3)	(0.5,0.1)	(0.4,0.2)	(0.3,0.3)	(1.8,0.9)

Table 5: Elements of the laplacian matrix of the IFIR D_2

M_2^{SL}	a_1	a_2	a_3	a_4	a_5
a_1	(1.1,1.9)	(0.5,0.1)	(0.1,0.5)	(0.3,0.5)	(0.2,0.8)
a_2	(0.1,0.5)	(1.6,1.6)	(0.5,0.4)	(0.6,0.1)	(0.4,0.6)
a_3	(0.5,0.1)	(0.6,0.4)	(2.1,1.0)	(0.9,0.1)	(0.1,0.4)
a_4	(0.5,0.3)	(0.1,0.6)	(0.3,0.7)	(1.7,1.8)	(0.8,0.2)
a_5	(0.8,0.1)	(0.8,0.2)	(0.1,0.1)	(0.2,0.8)	(1.9,1.2)

Table 6: Elements of the laplacian matrix of the IFIR D_3

M_3^{SL}	a_1	a_2	a_3	a_4	a_5
a_1	(2.0,0.7)	(0.9,0.1)	(0.1,0.2)	(0.4,0.1)	(0.6,0.3)
a_2	(0.7,0.2)	(2.4,1.3)	(0.4,0.6)	(0.6,0.3)	(0.7,0.2)
a_3	(0.2,0.1)	(0.6,0.4)	(1.5,1.1)	(0.1,0.4)	(0.6,0.2)
a_4	(0.1,0.4)	(0.4,0.6)	0.4,0.1)	(1.6,1.4)	(0.6,0.3)
a_5	(0.6,0.2)	(0.9,0.1)	(0.3,0.6)	(0.3,0.6)	(2.1,1.5)

The Signlesslaplacian energy(SLE) of each IFG is determined as:

$$Spectrum\,of\;M_1^{SL}\left(\mu\left(D_1\right)\right)=\{6.6795+0.0000i, 4.2283+0.1776i, 4.2283-0.1776i, 4.8867+0.0000i, 4.5773+0.0000i\}$$

$$Spectrum\,of\;M_1^{SL}\left(\gamma\left(D_1\right)\right)=\{6.0258, 4.4359, 3.4075, 3.9624, 3.7685\}$$

$$SLE\left(D_1\right)=\left[8.2330, 7.2000\right]$$

$$Spectrum\,of\ M_2^{SL}\left(\mu\left(D_2\right)\right)=\{6.7997+0.0000i, 4.1930+0.1203i, 4.1930-0.1203i,$$
$$5.0072+0.3952i, 5.0072\_0.3952i\}$$
$$Spectrum\,of\ M_2^{SL}\left(\gamma\left(D_2\right)\right)=\{6.1015+0.0000i, 4.3010+0.5300i, 4.3010-0.5300i,$$
$$4.1930+0.0000i, 3.6036+0.0000i\}$$
$$SLE\left(D_2\right)=\left[8.5108, 7.7076\right]$$

$$Spectrum\,of\ M_3^{SL}\left(\mu\left(D_3\right)\right)=\{9.4845, 7.0550, 5.5273, 6.1391, 4.0941\}$$

$$Spectrum\,of\ M_3^{SL}\left(\gamma\left(D_3\right)\right)=\{2.2586+0.0000i, 5.0346+0.0000i, 3.3344+0.0000i,$$
$$3.6362+0.1019i, 3.6362-0.1019i\}$$

$$SLE\left(D_3\right)=\left[10.4919, 6.2511\right]$$

The weight of every expert can determined as :

$$W_i=\left(\left(W_\mu\right)_i,\left(W_\gamma\right)_i\right)=\left[\frac{SLE\left(\left(D_\mu\right)_i\right)}{\sum_{l=1}^{m}SLE\left(\left(D_\mu\right)_l\right)},\frac{SLE\left(\left(D_\gamma\right)_i\right)}{\sum_{l=1}^{m}SLE\left(\left(D_\gamma\right)_l\right)}\right]\ for\ i=1,2,3,\ldots,m$$

$$W_1=\left(0.3023, 0.3403\right), W_2=\left(0.3125\ , 0.3643\right)\ W_3=\left(0.3852\ , 0.2954\right)$$

based on which using Intutionistic fuzzy weighted averaging (IFWA) operator, the fused IFIR is calculated as shown in table7.

Use the total administrator to combine all the individual IFIRs $M_k=\left(\gamma_{ij}^{(k)}\right)_{5\times5}\left(k=1,2,3,4\right)$ into the aggregate IFIR $M=\left(\gamma_{ij}\right)_{5\times5}$ Here we apply the intuitionistic fuzzy weighted averaging (IFWA) administrator [ ] to meld the individual IFIR by utilizing' **VIKOR'** method.Thus, we have

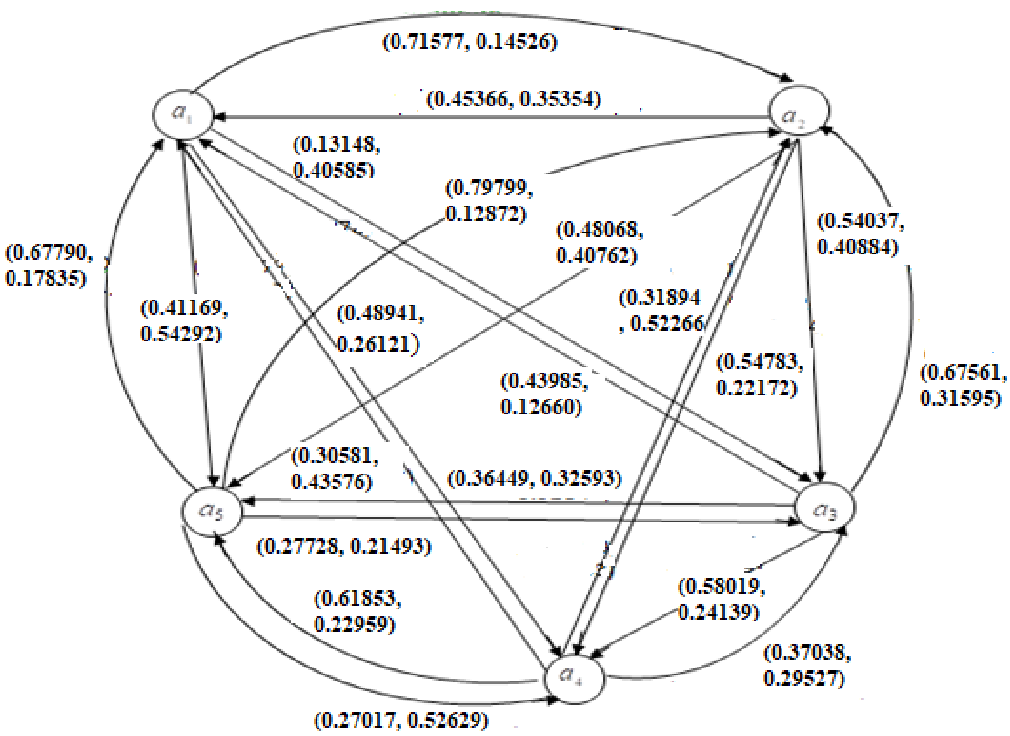
$$IFW\,\gamma_{ij}=\left(1-\underset{k=1}{\overset{s}{\pi}}\left(1-\left(\mu_{ij}\right)^k\right)^{w_k},\underset{k=1}{\overset{s}{\pi}}\left(\gamma_{ij}^{(k)}\right)^{w_k}\right)$$

Table 7: The collective IFIR of all the above individual IFIRs

D	a_1	a_2	a_3	a_4	a_5
a_1	(0,0)	(0.71577, 0.14526)	(0.13148, 0.40585)	(0.48941, 0.26121)	(0.41169, 0.54292)
a_2	(0.45366, 0.35354)	(0,0)	(0.54037, 0.40884)	(0.54783, 0.22172)	(0.48068, 0.40762)
a_3	(0.43985, 0.12660)	(0.67561, 0.31595)	(0,0)	(0.58019, 0.24139)	(0.36449, 0.32593)

a_4	(0.30581, 0.43576)	(0.31894, 0.52266)	(0.37038, 0.29527)	(0,0)	(0.61853, 0.22959)
a_5	(0.67790, 0.17835)	(0.79799, 0.12872)	(0.27728, 0.21493)	(0.27017, 0.52629)	(0,0)

In the coordinated system comparing to an aggregate IFPR above, we select those intuitionistic numbers whose membership degrees $T_{jk} \geq 0.5(j,k=1,2,3,4,5)$ and resulting partial diagram is appeared in figure.



Ascertain the out degrees $Out-d(a_j)(j=1,2,,3,4,5)$ of all criteria in a partial directed network as follows:

$Out-d(a_1)=(1.74835,1.35524)$, $Out-d(a_2)=(2.02254,1.39172)$,

$Out-d(a_3)=(2.06014,1.00987)$, $Out-d(a_4)=(1.61366,1.48328)$,

$Out-d(a_5)=(2.02334,1.04829)$

As per membership degrees of $Out-d(a_j)(j=1,2,,3,4,5)$, we have the positioning of the factors $a_j\ (j=1,2,,3,4,5)$as:

$a_3 > a_2 > a_5 > a_1 > a_4$

Thus the best choice is a_3 ie Hyundai India .

2.2 Flexibly Chain Associations In The Construction Business

Consider an issue in regards to the determination of critical factors used to get to the likely partners of the organization. Gracefully chain the executives relies upon vital connection between organizations identified with flexibly chain. By successful coordination, organizations profit by lower cost, lower stock levels, data sharing and in this way more grounded serious edge. critical factors may affect the coordination of organizations. Among them coming up next is the rundown of four critical factors[ ].

Cf_1 : Information integration

Cf_2 : Collaboration and coordination

Cf_3 : Focus on the client

Cf_4 : Strategic planning

So as to rank the over four critical factors $Cf_i\left(i=1,2,3,4\right)$ we welcomed advisory group of three decision makers $e_k\left(k=1,2,3\right)$. These leaders think about each pair of these components and give instuitionistic fuzzy preferences contained in the IFPRS

$M_k=\left[\gamma_{ij}^k\right]_{4\times 4}\left(k=1,2,3\right)$ respectively.

$$M_1=\begin{bmatrix} (0,0) & (0.6,0.2) & (0.9,0) & (0.7,0.2) \\ (0.5,0.4) & (0,0) & (0.3,0.7) & (0.8,0) \\ (0,0.9) & (0.8,0.2) & (0,0) & (0.1,0.9) \\ (0.4,0.6) & (0.5,0.4) & (0.9,0.1) & (0,0) \end{bmatrix}$$

$$M_2=\begin{bmatrix} (0,0) & (0.3,0.2) & (0.7,0.3) & (0.5,0.5) \\ (0.9,0) & (0,0) & (0.7,0.2) & (0.1,0.7) \\ (0.6,0.3) & (0.4,0.6) & (0,0) & (0.3,0.6) \\ (0.8,0.2) & (0.7,0.1) & (0.6,0.3) & (0,0) \end{bmatrix}$$

$$M_3=\begin{bmatrix} (0,0) & (0.4,0.9) & (0.6,0.3) & (0.7,0.2) \\ (0.9,0.1) & (0,0) & (0.7,0.3) & (0.1,0.2) \\ (0.4,0.5) & (0.6,0.2) & (0,0) & (0.4,0.2) \\ (0.5,0.2) & (0.6,0.2) & (0.4,0.5) & (0,0) \end{bmatrix}$$

$$M^{SL}_1\left[\mu(G)\right]=\begin{bmatrix} 2.2 & 0.6 & 0.9 & 0.7 \\ 0.5 & 1.6 & 0.3 & 0.8 \\ 0 & 0.8 & 0.9 & 0.1 \\ 0.4 & 0.5 & 0.9 & 1.8 \end{bmatrix}, \quad M^{SL}_1\left[\gamma(G)\right]=\begin{bmatrix} 0.4 & 0.2 & 0 & 0.2 \\ 0.4 & 1.1 & 0.7 & 0 \\ 0.9 & 0.2 & 2.0 & 0.9 \\ 0.6 & 0.4 & 0.1 & 1.1 \end{bmatrix}$$

The Signlesslaplacian energy(SLE) of M_1 (G) is determined as:

$$\text{Spectrum of } M_1^{SL}\left[\mu(G)\right]=\left\{6.5703+0.0000i, 4.7545+0.0000i, 4.0876+0.3326i, 4.0876-0.3326i\right\}$$

$$\text{Spectrum of } M_1^{SL}\left[\gamma(G)\right]=\left\{5.0458+0.0000i, 2.4981+0.0000i, 3.1281+0.30821i, 3.1281-0.30821\right\}$$

$$SLE\left[M_1(G)\right]=\left[6.6272, 4.7110\right]$$

$$M_2^{SL}\left[\mu(G)\right]=\begin{bmatrix}1.5 & 0.3 & 0.7 & 0.5\\ 0.9 & 1.7 & 0.7 & 0.1\\ 0.6 & 0.4 & 1.3 & 0.3\\ 0.8 & 0.7 & 0.6 & 2.1\end{bmatrix}, \quad M_2^{SL}\left[\gamma(G)\right]=\begin{bmatrix}1.0 & 0.2 & 0.3 & 0.5\\ 0 & 0.9 & 0.2 & 0.7\\ 0.3 & 0.6 & 1.5 & 0.6\\ 0.2 & 0.1 & 0.3 & 0.6\end{bmatrix}$$

The Signlesslaplacian energy(SLE) of M_2 (G) is determined as:

$$Spectrum\ of\ M_2^{SL}\left[\mu(G)\right]=\left\{6.5895+0.0000i, 4.5257+0.2679i, 4.5257-0.2679i, 4.1591+0.0000i\right\}$$

$$Spectrum\ of\ M_2^{SL}\left[\gamma(G)\right]=\left\{4.2382, 2.4141, 2.6000, 2.7477\right\}$$

$$SLE\left[M_2(G)\right]=\left[6.6579, 4.0000\right]$$

$$M_3^{SL}\left[\mu(G)\right]=\begin{bmatrix}1.7 & 0.4 & 0.6 & 0.7\\ 0.9 & 1.7 & 0.7 & 0.1\\ 0.4 & 0.6 & 1.4 & 0.4\\ 0.5 & 0.6 & 0.4 & 1.5\end{bmatrix}, \quad M_3^{SL}\left[\gamma(G)\right]=\begin{bmatrix}1.4 & 0.9 & 0.3 & 0.2\\ 0.1 & 0.6 & 0.3 & 0.2\\ 0.5 & 0.2 & 0.9 & 0.2\\ 0.2 & 0.2 & 0.5 & 0.9\end{bmatrix}$$

The Signlesslaplacian energy(SLE) of M_3 (G) is determined as:

$$Spectrum\ of\ M_3^{SL}\left[\mu(G)\right]=\left\{6.4176+0.0000i, 4.3000+0.0000i, 4.0912+0.1436i, 4.0912-0.1436i\right\}$$

$$Spectrum\ of\ M_3^{SL}\left[\gamma(G)\right]=\left\{4.0192+0.0000i, 2.5898+0.1914i+2.5898-0.1914i+2.2012+0.0000i\right\}$$

$$SLE\left[M_3(G)\right]=\left[6.3218, 3.8521\right]$$

The weight of each decision maker $e_k\left(k=1,2,3\right)$ can be determined as

$$W_i=\left(\frac{SLE\left(M_1^{SL}\left(e_1\right)\right)}{\sum_{i=1}^{n}SLE\left(M_i\left(e_k\right)\right)_i}, \frac{SLE\left(M_2^{SL}\left(e_1\right)\right)}{\sum_{i=1}^{n}SLE\left(M_i\left(e_k\right)\right)_i}, \frac{SLE\left(M_3^{SL}\left(e_1\right)\right)}{\sum_{i=1}^{n}SLE\left(M_i\left(e_k\right)\right)_i}\right)$$

$$W_1=\left(0.3380, 0.3750\right), W_2=\left(0.3396, 0.3184\right), W_3=\left(0.3224, 0.3066\right)$$

based on which using Intutionistic fuzzy weighted averaging (IFWA) operator, the fused IFIR is calculated as shown in table 8.

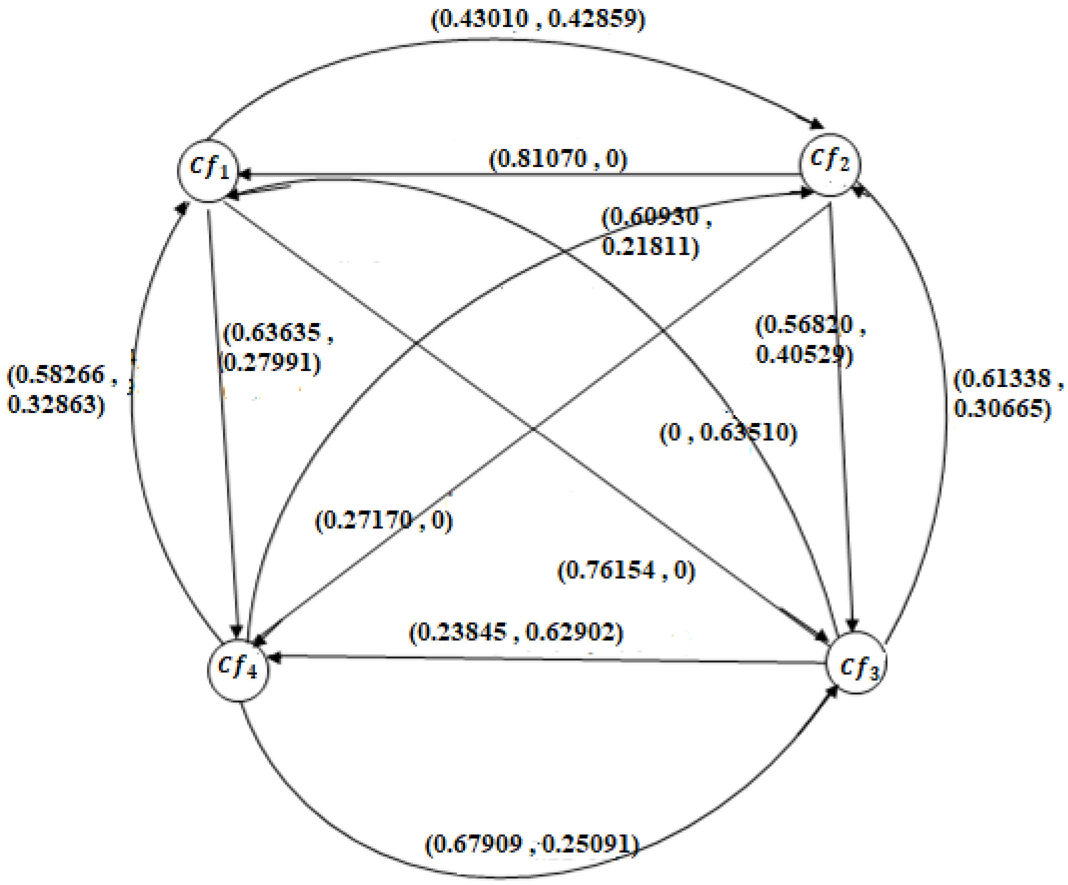
Use the total administrator to combine all the individual IFIRS $M_k = \left(\gamma_{ij}^{(k)}\right)_{4\times4} (k=1,2,3)$ into the aggregate IFIR $M = \left(\gamma_{ij}\right)_{4\times4}$ Here we apply the intuitionistic fuzzy weighted averaging (IFWA) administrator [ ] to meld the individual IFIR by utilizing**' EXTENDED VIKOR'** method.Thus, we have

$$IFWA\ \gamma_{ij} = \left(\frac{\underset{i=1}{\overset{n}{\pi}} \left(\mu_{\alpha_i}\right)^{w_i}}{\underset{i=1}{\overset{n}{\pi}} \left(\mu_{\alpha_i}\right)^{w_i} + \underset{i=1}{\overset{n}{\pi}} \left(1-\mu_{\alpha_i}\right)^{w_i}}, \frac{\underset{i=1}{\overset{n}{\pi}} \left(\gamma_{\alpha_i}\right)^{w_i}}{\underset{i=1}{\overset{n}{\pi}} \left(\gamma_{\alpha_i}\right)^{w_i} + \underset{i=1}{\overset{n}{\pi}} \left(1-\gamma_{\alpha_i}\right)^{w_i}} \right)$$

Table8: The collective IFIR of all the above individual IFPRS

M	Cf_1	Cf_2	Cf_3	Cf_4
Cf_1	(0,0)	(0.43010 , 0.42859)	(0.76154 , 0)	(0.63635 , 0.27991)
Cf_2	(0.81070 , 0)	(0 , 0)	(0.56820 , 0.40529)	(0.27170 , 0)
Cf_3	(0 , 0.63510)	(0.61338 , 0.30665)	(0 , 0)	(0.23845 , 0.62902)
Cf_4	(0.58266 , 0.32863)	(0.60930 , 0.21811)	(0.67909 , 0.25091)	(0, 0)

In the coordinated system comparing to an aggregate IFPR above, we select those intuitionistic numbers whose membership degrees $T_{jk} \geq 0.5\left(j,k=1,2,3,4\right)$ and resulting partial diagram is appeared in figure.



Ascertain the out degrees $Out-d(Cf_j)(j=1,2,,3,4)$ of all criteria in a partial directed network as follows:

$$Out-d\,(Cf_1)=(1.82799,0.70850),\,Out-d\,(Cf_2)=(1.65060,0.40529),$$
$$Out-d\,(Cf_3)=(0.85138,1.57077)\ ,\ Out-d\,(Cf_4)=(1.87105,0.79765)$$

As per membership degrees of $Out-d(Cf_j)(j=1,2,,3,4)$, we have the positioning of the factors $Cf_j\,(j=1,2,,3,4)$as:

$$Cf_4 > Cf_1 > Cf_2 > Cf_3$$

Thus the best choice is Cf_4 i.e Strategic planning.

2.3 Evaluation Of The Schemes For Development Of Agriculture And Farmers's Welfare

In this section we focus on evaluations of schemes for development of agriculture and farmers's welfare.The department of agriculture & cooperation was earlier implementing many schemes for development of agriculture and farmer's welfare in the country. The government of India has introduced schemes to meet the requirements of farmers for storing farm produce, processed farm produce, agricultural inputs and marketing.Now we are recommended five agricultural schemes S_1, S_2, S_3, S_4 and S_5.

S_1: National Food Security Mission(NFSM)

S_2: National Mission on Sustainable Agriculture(NMSA)

S_3: National Mission on Oilseeds and Oilpalm(NMOOP)

S_4: National Mission on agricultural Extention and Technology(NMAET)

S_5: Integrated Scheme for Agriculture Marketing(ISAM)

To select the optimal scheme, the government selected four experts $e_k(k=1,2,3,4)$ to evaluate the five schemes. Based on their investigation, the experts compare each pair of schemes and give individual judgements using following IFPRs

$$M_k = \left[\gamma_{ij}^{(k)}\right]_{5\times 5}(k=1,2,3,4).$$

$$M_1 = \begin{bmatrix} (0,0) & (0.5,0.3) & (0.4,0.2) & (0.6,0.3) & (0.5,0.1) \\ (0.7,0.2) & (0,0) & (0.4,0.5) & (0.6,0.4) & (0.5,0.3) \\ (0.5,0.3) & (0.4,0.5) & (0,0) & (0.6,0.2) & (0.3,0.4) \\ (0.3,0.5) & (0.6,0.4) & (0.6,0.3) & (0,0) & (0.7,0.1) \\ (0.4,0.3) & (0.5,0.2) & (0.6,0.4) & (0.2,0.6) & (0,0) \end{bmatrix}$$

$$M_2 = \begin{bmatrix} (0,0) & (0.6,0.3) & (0.7,0.2) & (0.4,0.4) & (0.5,0.3) \\ (0.4,0.5) & (0,0) & (0.5,0.3) & (0.7,0.1) & (0.2,0.6) \\ (0.5,0.5) & (0.8,0.2) & (0,0) & (0.4,0.5) & (0.7,0.3) \\ (0.7,0.3) & (0.4,0.5) & (0.6,0.2) & (0,0) & (0.3,0.3) \\ (0.8,0.2) & (0.6,0.4) & (0.4,0.3) & (0.3,0.1) & (0,0) \end{bmatrix}$$

$$M_3 = \begin{bmatrix} (0,0) & (0.5,0.3) & (0.7,0.1) & (0.4,0.2) & (0.6,0.4) \\ (0.6,0.3) & (0,0) & (0.3,0.4) & (0.4,0.2) & (0.5,0.1) \\ (0.3,0.5) & (0.6,0.1) & (0,0) & (0.4,0.6) & (0.7,0.2) \\ (0.5,0.2) & (0.7,0.1) & (0.6,0.3) & (0,0) & (0.5,0.4) \\ (0.3,0.7) & (0.5,0.4) & (0.4,0.3) & (0.3,0.6) & (0,0) \end{bmatrix}$$

$$M_4 = \begin{bmatrix} (0,0) & (0.7,0.2) & (0.5,0.3) & (0.6,0.1) & (0.4,0.5) \\ (0.5,0.2) & (0,0) & (0.2,0.4) & (0.4,0.5) & (0.6,0.2) \\ (0.2,0.7) & (0.4,0.3) & (0,0) & (0.8,0.1) & (0.5,0.2) \\ (0.4,0.5) & (0.3,0.3) & (0.2,0.6) & (0,0) & (0.5,0.2) \\ (0.6,0.3) & (0.4,0.1) & (0.2,0.5) & (0.8,0.2) & (0,0) \end{bmatrix}$$

The Signlesslaplacian matrices of IFDGs $SL(D_k)=M_k^{SL}\,(k=1,2,3,4)$

$$M_1^{SL}\left[\mu(G)\right]=\begin{bmatrix}2.0&0.5&0.4&0.6&0.5\\0.7&2.2&0.4&0.6&0.5\\0.5&0.4&1.8&0.6&0.3\\0.3&0.6&0.6&2.2&0.7\\0.4&0.5&0.6&0.2&1.7\end{bmatrix},\quad M_1^{SL}\left[\gamma(G)\right]=\begin{bmatrix}0.9&0.3&0.2&0.3&0.1\\0.2&1.4&0.5&0.4&0.3\\0.3&0.5&1.4&0.2&0.4\\0.5&0.4&0.3&1.3&0.1\\0.3&0.2&0.4&0.6&1.5\end{bmatrix}$$

The Signlesslaplacian energy(SLE) of M_1 (G) is determined as:

$$\textit{Spectrum of } M_1^{SL}\left[\mu(G)\right]=\{8.0188+0.0000i, 5.1636+0.2145\mathrm{i}, 5.1636-0.2145i, 5.7734+0.0000i, 5.5806+0000i\}$$

$$\textit{Spectrum of } M_1^{SL}\left[\gamma(G)\right]=\{5.3221+0.0000i, 2.9546+0.0000\mathrm{i}, 3.7854+0.1477\mathrm{i}, 3.7854-0.1477\mathrm{i}, 3.6525+0.0000\mathrm{i}\}$$

$$SLE\left[M_1(G)\right]=[9.9397, 6.5183]$$

$$M_2^{SL}\left[\mu(G)\right]=\begin{bmatrix}2.2&0.6&0.7&0.4&0.5\\0.4&1.8&0.5&0.7&0.2\\0.5&0.8&2.4&0.4&0.7\\0.7&0.4&0.6&2.0&0.3\\0.8&0.6&0.4&0.3&2.1\end{bmatrix},\quad M_2^{SL}\left[\gamma(G)\right]=\begin{bmatrix}1.2&0.3&0.2&0.4&0.3\\0.5&1.5&0.3&0.1&0.6\\0.5&0.2&1.5&0.5&0.3\\0.3&0.5&0.2&1.3&0.3\\0.2&0.4&0.3&0.1&1.0\end{bmatrix}$$

The Signlesslaplacian energy(SLE) of M_2 (G) is determined as:

$$\textit{Spectrum of } M_2^{SL}\left[\mu(G)\right]=\{8.5518+0.0000i, 6.2422+0.0000i, 5.4550+0.0000i, 5.6255+0.2210i, 5.6255-0.2210i\}$$

$$\textit{Spectrum of } M_2^{SL}\left[\gamma(G)\right]=\{5.2676+0.0000i, 3.2577+0.0000i, 3.5645+0.0000i, 3.7051+0.0756i, 3.7051-0.0756i\}$$

$$SLE\left[M_2(G)\right]=[10.5341, 6.5052]$$

$$M_3^{SL}\left[\mu(G)\right]=\begin{bmatrix} 2.2 & 0.5 & 0.7 & 0.4 & 0.6 \\ 0.6 & 1.8 & 0.3 & 0.4 & 0.5 \\ 0.3 & 0.6 & 2.0 & 0.4 & 0.7 \\ 0.5 & 0.7 & 0.6 & 2.3 & 0.5 \\ 0.3 & 0.5 & 0.4 & 0.3 & 1.5 \end{bmatrix}, \quad M_3^{SL}\left[\gamma(G)\right]=\begin{bmatrix} 1.0 & 0.3 & 0.1 & 0.2 & 0.4 \\ 0.3 & 1.0 & 0.4 & 0.2 & 0.1 \\ 0.5 & 0.1 & 1.4 & 0.6 & 0.2 \\ 0.2 & 0.1 & 0.3 & 1.0 & 0.4 \\ 0.7 & 0.4 & 0.3 & 0.6 & 2.0 \end{bmatrix}$$

The Signlesslaplacian energy(SLE) of M_3 (G) is determined as:

$$\text{Spectrum of } M_3^{SL}\left[\mu(G)\right]=\{7.8405+0.0000i, 5.5128+0.2214i, 5.5128-0.2214i,$$
$$5.5995+0.0000i, 4.9344+0.0000i\}$$
$$\text{Spectrum of } M_2^{SL}\left[\gamma(G)\right]=\{5.6054, 4.0118, 2.8268, 3.5053, 3.2507\}$$

$$SLE\left[M_3(G)\right]=\left[9.8306, 6.4000\right]$$

$$M_4^{SL}\left[\mu(G)\right]=\begin{bmatrix} 2.2 & 0.7 & 0.5 & 0.6 & 0.4 \\ 0.5 & 1.7 & 0.2 & 0.4 & 0.6 \\ 0.2 & 0.4 & 1.9 & 0.8 & 0.5 \\ 0.4 & 0.3 & 0.2 & 1.4 & 0.5 \\ 0.6 & 0.4 & 0.2 & 0.8 & 2.0 \end{bmatrix}, \quad M_4^{SL}\left[\gamma(G)\right]=\begin{bmatrix} 1.1 & 0.2 & 0.3 & 0.1 & 0.5 \\ 0.2 & 1.3 & 0.4 & 0.5 & 0.2 \\ 0.7 & 0.3 & 1.3 & 0.1 & 0.2 \\ 0.5 & 0.3 & 0.6 & 1.6 & 0.2 \\ 0.3 & 0.1 & 0.5 & 0.2 & 1.1 \end{bmatrix}$$

The Signlesslaplacian energy(SLE) of M_4 (G) is determined as:

$$\text{Spectrum of } M_4^{SL}\left[\mu(G)\right]=\{7.4882, 5.4512, 4.7137, 5.0043, 4.9426\}$$
$$\text{Spectrum of } R_4^{L}\left[\gamma(G)\right]=\{5.2241+0.0000i, 3.9138+0.0000i, 3.5449+0.0000i,$$
$$3.2572+0.0895i, 3.2572-0.0895i\}$$

$$SLE\left[M_4(G)\right]=\left[9.2000, 6.4114\right]$$

Then the weight of each expert can computed as :

$$W_k=\left((W_\mu)_k,(W_\gamma)_k\right)=\left[\frac{SLE\left((D_\mu)_k\right)}{\sum_{l=1}^{4} SLE\left((D_\mu)_k\right)_l}, \frac{SLE\left((D_\gamma)_k\right)}{\sum_{l=1}^{4} SLE\left((D_\gamma)_k\right)_l}\right]$$

$$W_1=(0.2516, 0.2523), W_2=(0.2667, 0.2518), W_3=(0.2489, 0.2477)$$

$$W_4 = (0.2329, 0.2482)$$

based on which using Intutionistic fuzzy weighted averaging (IFWA) operator, the fused IFIR is calculated as shown in table 9.

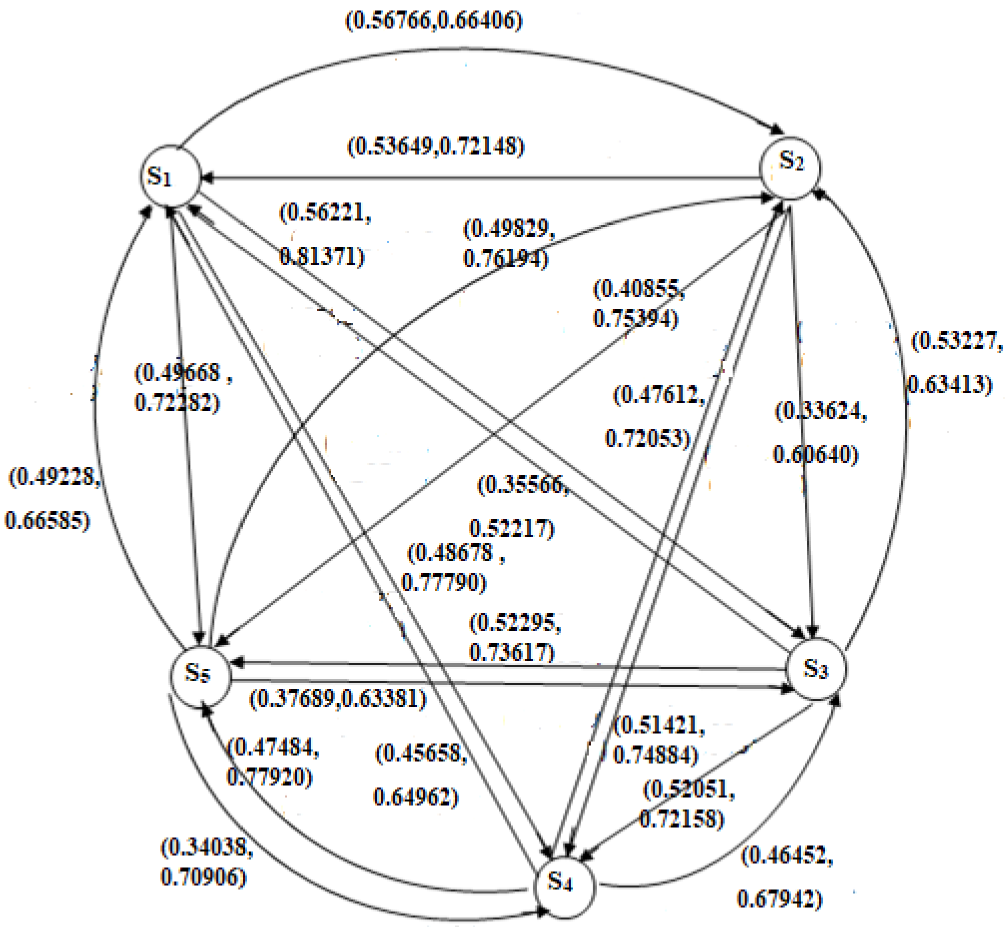
Utilize the aggregation operator to fuse all the individual IFPRs $R_k = \left(\gamma_{ij}^{(k)}\right)_{5\times5} (k = 1,2,3,4)$ into the collective IFIR $M = \left(\gamma_{ij}\right)_{5\times5}$.Here we apply the intuitionistic fuzzy weighted averaging (IFWA) operator [ ] to fuse the individual IFPR by using **Multimooramethod**.Thus, we have

$$IFWA\gamma_{ij} = \left(\underset{k=1}{\overset{s}{\pi}} \left(\mu_{ij}^{(k)}\right)^{w_k}, 1 - \underset{k=1}{\overset{s}{\pi}} \left(\gamma_{ij}^{(k)}\right)^{w_k} \right)$$

Table 9: The collective IFIR of all the above individual IFPRs

	S_1	S_2	S_3	S_4	S_5
S_1	(0,0)	(0.56766, 0.66406)	(0.56221, 0.81371)	(0.48678 , 0.77790)	(0.49668 , 0.72282)
S_2	(0.53649, 0.72148)	(0,0)	(0.33624, 0.60640)	(0.51421, 0.74884)	(0.40855, 0.75394)
S_3	(0.35566, 0.52217)	(0.53227, 0.63413)	(0,0)	(0.52051, 0.72158)	(0.52295, 0.73617)
S_4	(0.45658, 0.64962)	(0.47612, 0.72053)	(0.46452, 0.67942)	(0,0)	(0.47484, 0.77920)
S_5	(0.49228, 0.66585)	(0.49829, 0.76194)	(0.37689, 0.63381)	(0.34038, 0.70906)	(0,0)

In the coordinated system comparing to an aggregate IFPR above, we select those intuitionistic numbers whose membership degrees $T_{jk} \geq 0.5(j,k = 1,2,3,4,5)$ and resulting partial diagram is appeared in figure.



Ascertain the out degrees $Out-d(x_j)(j=1,2,,3,4,5)$ of all criteria in a partial directed network as follows:

$Out-d(S_1)=(2.11333,2.97849)$, $Out-d(S_2)=(1.79549,2.83066)$,

$Out-d(S_3)=(1.93139,2.61405)$,

$Out-d(S_4)=(1.87206,2.82877)$, $Out-d(S_5)=(1.70784,2.77066)$

As per membership degrees of $Out-d(S_j)(j=1,2,,3,4,5)$, we have th positioning of the factors $x_j(j=1,2,,3,4,5)$ as:

$$S_1 > S_3 > S_4 > S_2 > S_5$$

Thus the best choice is S_1 ie National Food Security Mission(NFSM)

3. CONCLUSION

An Intuitionistic fuzzy model is pushed off in PC innovation, correspondence, organizing, when the idea of indeterminacy is current. In this paper, we have acquainted persuaded original thoughts requesting in group decision-making dependent on IFIRs is introduced to delineate the relevance of the proposed ideas of Intuitionistic Fuzzy Graphs. These wisdom's are additionally exhibited with real stage delineation. Additionally we perceive the status of the best one.

REFERENCES

[1] Atanassov, K.T. Intuitionistic fuzzy sets. Fuzzy Sets Syst. 1986, 20, 87–96.
[2] Gutman, I. The energy of a graph. Ber. Math. Stat. Sekt. Forsch. Graz. 1978, 103, 1–22.
[3] Gutman, I. The Energy of a Graph: Old and New Results, Algebraic Combinatorics and Applications; Springer:Berlin/Heidelberg, Germany, 2001; pp. 196–211.
[4] Gutman, I.; Zhou, B. Laplacian energy of a graph. In Linear Algebra and Its Applications; Elsevier: New York, NY, USA, 2006; Volume 414, pp. 29–37.
[5] Gutman, I.; Robbiano, M.; Martins, E.A.; Cardoso, D.M.; Medina, L.; Rojo, O. Energy of line graphs. In Linear Algebra and Its Applications; Elsevier: New York, NY, USA, 2010; Volume 433, pp. 1312–1323.
[6] Erdos, P. Graph theory and probability, canad. J. Math. 1959, 11, 34–38.
[7] Zadeh, L.A. Fuzzy sets. Inf. Control 1965, 8, 338–353.
[8] Rosenfeld, A. Fuzzy Graphs, Fuzzy Sets and Their Applications; Zadeh, L.A., Fu, K.S., Shimura, M., Eds.; Academic Press: New York, NY, USA, 1975; pp. 77–95.
[9] Anjali, N.; Mathew, S. Energy of a fuzzy graph. Ann. Fuzzy Maths Inform. 2013, 6, 455–465.
[10] Praba, B.; Chandrasekaran, V.M.; Deepa, G. Energy of an intutionistic fuzzy graph. Ital. J. Pure Appl. Math.2014, 32, 431–444.
[11] Basha, S.S.; Kartheek, E. Laplacian energy of an intuitionistic fuzzy graph. Ind. J. Sci. Technol. 2015, 8, 1-7.
[12] Fan, Z.P.; Liu, Y. An approach to solve group decisionmaking problems with ordinal interval numbers. IEEE Trans. Syst. Man Cybern. B Cybern. 2010, 40, 1413– 1423.
[13] Biswas, P.; Pramanik, S.; Giri, B.C. TOPSIS method for multi-attribute group decision-making under single-valued neutrosophic environment. Neural Comput. Appl. 2016, 27, 727–737.