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An Intuitionistic Approach for Ranking OTA Websites under Multi Criteria Group Decision Making Framework

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***Abstract*—The transformations from approaches based on crisp set towards fuzzy set were introduced to include the uncertainty experienced in decision making. But the problem of hesitation about any alternative still prevailed among the decision makers. Later, an extension of fuzzy sets, the intuitionistic fuzzy sets, filled the gap between the degree of satisfaction and the degree of dissatisfaction encountered by the decision makers. Also, the biasness noticed while comparing a number of alternatives based on multiple criteria by a single person, necessitated for a multi criteria group decision making (MCGDM) approach. In this paper, we propose a hybrid model that combines the MCGDM techniques of intuitionistic fuzzy analytical hierarch process (IFAHP) and intuitionistic fuzzy multi objective optimization on the basis of ratio analysis (IFMOORA). The IFAHP technique is used to find the criteria weights and IFMOORA technique is used for overall ranking of OTA websites. To validate the proposed model, we apply it to rank online travel agencies (OTA) websites on the basis of a number of success factors. The model developed is flexible and can be further applied to various selection problems.**

***Keyword*—Intuitionistic fuzzy sets, Intuitionistic fuzzy MOORA, Intuitionistic fuzzy AHP, Online travel agency**

I. Introduction

THESE days, the decision making process has shifted from a single criterion to multiple conflicting criteria. This has popularized the use of multi criteria decision making (MCDM) approaches by researchers in various extant studies. Earlier, these studies were based on the crisp or exact inputs from the decision makers or experts, but it failed to incorporate the uncertainty and ambiguity faced by decision makers. This loophole was corrected by extending the decision making inputs based on crisp sets to fuzzy sets [19]. Fuzzy sets are efficient in handling the vagueness and impreciseness faced by experts in decision making, by specifying some degree of membership to each alternative. Still, the techniques based on fuzzy sets were not able to consider the degree of hesitation encountered by the decision makers. This necessitated for extending these sets to intuitionistic fuzzy sets (IFS) introduced by Atanassov [2]. This enabled the decision maker to include both his preferences and non-preferences in decision making simultaneously.

MCDM approaches evaluate each alternative over all criteria based on the inputs of a single expert, which is a biased approach. Thus, multi criteria group decision making (MCGDM) approaches were introduced to obtain the best solution based on information provided by multiple decision makers. It has been noticed that even though the decision makers may have same objective, their perception towards the problem may vary [13]. Earlier each decision maker was allocated equal weights, but later weighing them according to their expertise was found to be more consistent approach [15]. For calculation purpose, the inputs from each decision maker are combined using various aggregation operators, to get an aggregated intuitionistic fuzzy decision matrix.

Analytic Hierarchy Process (AHP) is a flexible and intuitive MCDM technique developed by Saaty [14]. The method transforms a complex problem into a hierarchical structure, which makes the problem organized and easy to analyze. It makes use of a pair-wise comparison scale to compare objects and find consistency of the problem. However, AHP is mainly used for evaluation purposes and not for ranking as the latter may demand for a large number of pair-wise comparisons and also via additive aggregation it may lose vital information [8]. In order to tackle these demerits, we use IFAHP to obtain criteria weights. Some of the previous researches which have used the technique for similar purposes are: Supplier selection [5], information system outsourcing [6], and many more.

Multi objective optimization on the basis of ratio analysis (MOORA) is another MCDM technique for optimizing two or more criteria simultaneously based on certain constraints. This method segregates all the criteria into beneficial (which are to be maximized) and non-beneficial (which are to be minimized), which are then used to rank alternatives or selecting the best from the available options. A distinguishing feature of MOORA as compared to its outranking counterparts is the use of ratio system for normalization procedure. Thus, it is considered to be a non-subjective method and more robust than existing MCDM techniques as it make use of cardinal or most recent data. In this paper we use IFMOORA for outranking purpose. The use of IFMOORA for ranking purpose is a new concept and till date it has been used previously for selection problem [17].

The growth in internet technology has led to an increase in purchase of goods and services by making use of e-commerce websites. The service sector has boomed with these advancements, especially, the online travel agency (OTA) websites usage has shown an increasing trend over the years. OTAs provide the customers a single platform for searching and booking airline tickets and hotel rooms through multiple vendors [9]. Though, much of the studies conducted in hospitality sector are related to hotels, less research has been conducted on OTAs. The success of an e-commerce website depends on the experience of previous visitors and the word-of-mouth spread by them. Here, we consider the following criteria: content quality, trust, support, service quality, customization [11] [12]. We add another criterion 'electronic word-of-mouth', which is similar to the concept of 'word-of-mouth' but extended over the internet. The word-of-mouth is a social communication, which acts as a powerful tool in the spread of information about the products or services, by previous purchasers. They have a high impact on potential customers as people believe others rather than the words communicated through the marketers [7].

In this paper, we combines the AHP and MOORA techniques extended over IFS under group decision making, to rank online travel agency (OTA) websites. Some of the earlier studies which have IFS for evaluation or ranking purposes are given by Table 1. The rest of the paper is structured as follows: Section 2 discusses the IFS based methods. The model is proposed in Section 3. Section 4 discusses a numerical illustration to validate the proposed model. The conclusion and discussions are given in Section 5.

Table 1: List of Previous Researches

Techniques	Authors	Purpose of the Study
IFGDM-Averaging operators	[16]	Evaluation of agro ecological regions
IFGDM-TOPSIS	[3]	Supplier selection
IFGDM-VIKOR	[6]	Information system outsourcing
IVIFGDM-Extended TOPSIS	[18]	Partner selection
IFGDM-TOPSIS	[1]	Machine Selection
IFAHP-IFMOORA	[17]	Project selection
IFAHP-IFAD	[5]	Supplier selection
IFGDM-TOPSIS	[4]	Hazardous waste management

II. Preliminaries

A. Intuitionistic Fuzzy Set Theory

Here, we discuss some of the concepts for working on intuitionistic sets which will be used throughout the paper.

Definition 1: (Intuitionistic fuzzy set) Let Y be a crisp set and let $I \subset Y$ be a fixed set. Then the IFS $\tilde{I}$ in Y is defined as,

$$\tilde{I} = \{(y, \mu_I(y), \vartheta_I(y) | y \in Y\} \tag{1}$$

where $\mu_I : Y \to [0,1]$ and $\vartheta_I : Y \to [0,1]$. $\mu_I(y)$ indicate the membership degree and $\vartheta_I(y)$ the non-membership degree of $y \in Y$ in I, respectively. Also, $0 \le \mu_I(y) + \vartheta_I(y) \le 1$, for all $y \in Y$. The hesitancy degree of y is denoted by $\pi_I(y)$, and calculated as $\pi_I(y) = 1 - \mu_I(y) - \vartheta_I(y)$.

Definition 2: An intuitionistic preference relation K on the set $Y = \{y_1, y_2, \ldots, y_n\}$ is represented by a matrix $(k_{is})_{n \times n}$, where $k_{is} = <(y_i, y_s), \mu(y_i, y_s), \vartheta(y_i, y_s)> \forall i, s = 1,2,\ldots,n$. Let us assume $k_{is} = (\mu_{is}, \vartheta_{is})$, where $\mu_{is} = \mu(y_i, y)$ and $\vartheta_{is} = \vartheta(y_i, y_s)$ denote the degree to which object y_i is preferred to the object y_s. Also, $\pi(y_i, y_s) = 1 - \mu_I(y_i, y_s) - \vartheta_I(y, y_s)$ indicates the hesitancy degree.

Definition 3: Intuitionistic fuzzy arithmetic operations

$$k_{is} \oplus k_{tl} = (\mu_{is} + \mu_{tl} - \mu_{is}\mu_{tl}, \vartheta_{is}\vartheta_{tl}) \tag{2}$$

$$k_{is} : k_{tl} = \left(\frac{\mu_{is}}{\mu_{tl}}, \frac{\vartheta_{is} - \vartheta_{tl}}{1 - \vartheta_{tl}}\right) \tag{3}$$

$$k_{is} \otimes k_{tl} = (\mu_{is}\mu_{tl}, \vartheta_{is} + \vartheta_{tl} - \vartheta_{is}\vartheta_{tl}) \tag{4}$$

Definition 4: Elements of a perfect multiplicative consistent intuitionistic preference relation $\acute{I} = (\acute{k}_{is})_{n \times n}$ matrix are denoted as $\acute{k}_{is} = (\acute{\mu}_{is}, \acute{\vartheta}_{is})$. For $s > i+1$,

$$\acute{\mu}_{is} = \frac{\sqrt{\prod_{t=i+1}^{s-1} \mu_{it}\mu_{ts}}}{\sqrt{\prod_{t=i+1}^{s-1} \mu_{it}\mu_{ts}} + \sqrt{\prod_{t=i+1}^{s-1} (1-\mu_{it})(1-\mu_{ts})}} \tag{5}$$

$$\acute{\vartheta}_{is} = \frac{\sqrt{\prod_{t=i+1}^{s-1} \vartheta_{it}\vartheta_{ts}}}{\sqrt{\prod_{t=i+1}^{s-1} \vartheta_{it}\vartheta_{ts}} + \sqrt{\prod_{t=i+1}^{s-1} (1-\vartheta_{it})(1-\vartheta_{ts})}} \tag{6}$$

For $s = i+1$ we take $\acute{k}_{is} = k_{is}$ and for $s < i$ we take $\acute{k}_{is} = (\acute{\vartheta}_{si}, \acute{\mu}_{si})$.

Definition 5: An intuitionistic preference relation R is acceptable if it satisfy the consistency condition,

$$d(I, \acute{I}) < \epsilon \tag{7}$$

where $d(I, \acute{I})$ is the distance measure between the given intuitionistic relation I and its corresponding perfect multiplicative consistent intuitionistic preference relation $\acute{I}$ given by,

$$d(I,\acute{I})=\frac{1}{2(n-1)(n-2)}\sum_{i=1}^{n}\sum_{s=1}^{n}\left(|\acute{\mu}_{is}-\mu_{is}|+|\acute{\vartheta}_{is}-\vartheta_{is}|+|\acute{\pi}_{is}-\pi_{is}|\right) \quad (8)$$

where ε is the consistency threshold.

Definition 6: Let the importance of gth decision maker be an IFN, $D_g=\{\mu_g,\vartheta_g,\pi_g\}$. The relative importance of decision maker, λ_g is given by,

$$\lambda_g=\frac{\left(\mu_g+\pi_g\left(\frac{\mu_g}{\mu_g+\pi_g}\right)\right)}{\sum_{g=1}^{l}\left(\mu_g+\pi_g\left(\frac{\mu_g}{\mu_g+\pi_g}\right)\right)} \quad (9)$$

So that $\sum_{g=1}^{l}\lambda_g=1$

Definition 7: Intuitionistic fuzzy weighted averaging operator (IFWA)

$$IFWA_\lambda(k_{is}^g)=\left(1-\prod_{g=1}^{l}(1-\mu_{is}^g)^{\lambda_g},\prod_{g=1}^{l}(\vartheta_{is}^g)^{\lambda_g}\right)$$
$$(i,s=1,\ldots,n) \quad (10)$$

Definition 8: Intuitionistic fuzzy averaging operator (IFA)

$$IFA(k_{is})=\left(1-\prod_{i=1}^{n}(1-\mu_{is})^{\frac{1}{n}},\prod_{i=1}^{n}(\vartheta_{is})^{\frac{1}{n}}\right)(i,s=1,\ldots,n) \quad (11)$$

Detecting the object from the video is the first step to tracking an object. Detection of an interesting moving object can be achieved by different existing techniques such as frame differencing, optical flow, background subtraction, segmentation, point detectors [3] as shown in Figure 2.

B. *Intuitionistic Fuzzy Analytic Hierarchy Process*

The steps for performing the IFAHP technique are as follows:

Step 1: Let the set of alternatives be $H=\{H_1,H_2,\ldots,H_n\}$ and criteria be $J=\{J_1,J_2,\ldots,J_m\}$. The pair-wise comparison matrix of criteria and performance value matrix of alternatives are formed using IFNs given by Table 2.

Step 2: Form the group of decision makers, $D=\{D_1,D_2,\ldots,D_l\}$ and determine the importance degree for each. Table 2 is used for assigning the importance weights to decision makers.

Step 3: Construct the intuitionistic preference relation matrices I_{1j}^g and I_2^g. The former indicates the performance value matrix of alternatives formed from the gth decision maker for jth criterion, and the latter presents the pair-wise comparison matrix of criteria established from gth DM. Construct a perfect multiplicative consistent intuitionistic preference relation $\acute{I}_{1j}^g$ and $\acute{I}_2^g$, which are acceptable if $d(I_{1j}^g,\acute{I}_{1j}^g)<\varepsilon$ and $d(I_2^g,\acute{I}_2^g)<\varepsilon$. Considering the conditions provided by Satty [14], the acceptable consistency threshold (ε) should be less than 0.1.

Table 2: Conversion of 1-9 scale to 0.1-0.9 scale

1-9 scale	0.1-0.9 scale	Linguistic Terms
1/9	0.1	Extremely not important (ENI)/beginner
1/7	0.2	Very strongly not important (VSNI)
1/5	0.3	Strongly not important (SNI)/practitioner
1/3	0.4	Moderately not important (MNI)
1	0.5	Equally important (EI)/proficient
3	0.6	Moderately important (MI)
5	0.7	Strongly important (SI)/expert
7	0.8	Very strongly important (VSI)
9	0.9	Extremely important (EXI)/master
Other values between 1/9 and 9	Other values between 0 and 1	Intermediate values used to present compromise

Step 4: Compute the relative importance of each decision maker using equation (9). Then, construct the aggregated intuitionistic fuzzy decision matrices $\acute{I}_{1j}$ and $\acute{I}_2$ by applying IFWA operator given in equation (10).

Step 5: Construct the normalized decision matrices $\acute{\acute{I}}_{1j}$ and $\acute{\acute{I}}_2$ using the arithmetic operations given by equations (2) and (3).

Step 6: The criteria weight vector $W_2=(W_{21},W_{22},\ldots,W_{2m})$ is established by making use of IFA operator, given by equation (11), on the Normalized decision matrix $\acute{\acute{I}}_2$.

C. *Intuitionistic Fuzzy Multi Objective Optimization based on Ratio Analysis*

The steps of performing the IFMOORA technique are as follows:

Step 1: Construct the matrix $\check{I}=(W_{11},W_{12},\ldots,W_{1m})$. The values of W_{1j} are computed by averaging the normalized matrix rows obtained by equation (11). The aggregated weighted intuitionistic fuzzy decision matrix $\acute{R}$ is obtained as,

$$\acute{I}=(W_{21}W_{11},W_{22}W_{12},\ldots,W_{2m}W_{1m}) \quad (12)$$

Arithmetic operators given by equations (2) and (4) are used for constructing $\acute{I}$.

Step 2: The criteria under consideration are divided into two groups as benefit (Ben_i) and cost $(\cos_i)$, and then their sum is computed for each alternative using equations,

$$Ben_i = \sum_{j=1}^{q} (\acute{\mu}_{is}, \acute{\vartheta}_{is})_j = (\acute{\mu}_{Ben_i}, \acute{\vartheta}_{Ben_i}) i=1,2,\ldots,n \quad (13)$$

$$\cos_i = \sum_{j=q+1}^{m} (\acute{\mu}_{is}, \acute{\vartheta}_{is})_j = (\acute{\mu}_{\cos_i}, \acute{\vartheta}_{\cos_i}) i=1,2,\ldots,n \quad (14)$$

where q indicates the number of benefit criteria and remaining $m-q$ denotes the number of cost criteria

Step 3: Defuzzify the sum of benefits and costs by using below equations respectively,

$$Defuz_i(Ben) = \frac{1-\acute{\vartheta}_{Ben_i}}{1-\acute{\pi}_{Ben_i}} i=1,2,\ldots,n \quad (15)$$

$$Defuz_i(\cos) = \frac{1-\acute{\vartheta}_{\cos_i}}{1-\acute{\pi}_{\cos_i}} i=1,2,\ldots,n \quad (16)$$

Step 4: Calculate the contribution value of each alternative using below equation and rank the alternatives in accordance to these values,

$$Contrib_i = Defuz_i(Ben) - Defuz_i(\cos) \quad (17)$$

The $Contrib_i$ values may be positive or negative. The ranking of $Contrib_i$ represents the final contribution of each alternative. The highest $Contrib_i$ value represents the best alternative.

III. Proposed Model

The proposed model for ranking OTA websites on the basis of success factors is composed of two approaches namely IFAHP and IFMOORA. The phases of the model are discussed below and represented by Figure 1:

Phase 1: Construction of Hierarchy

In this phase, the OTA websites and the criteria which will be used in ranking are determined and the decision hierarchy is formed. The objective of the proposed model is placed at the top level, the success factors at the middle, and the OTA websites to be ranked at the bottom.

Phase 2: Criteria Weight Calculation using IFAHP

In this phase, decision matrix is constructed to obtain criteria weights. The elements in the matrices are filled using the pair-wise comparison values provided by the experts, obtained through a structured interview. Next, the aggregated intuitionistic fuzzy decision matrix is constructed. Then we normalize decision matrix, which in turn ultimately provide us with the final criteria weights.

Phase 3: Rank Websites using IFMOORA

Ranking websites is done using the IFMOORA technique. Firstly, the decision matrix is formed by rating each alternative against each criterion which is provided by experts in OTA industry. Then the sum of costs and benefits are obtained using aggregated weighted intuitionistic fuzzy decision matrix. This helps to evaluate the contribution value. The alternative corresponding to highest contribution value is considered to be the best.

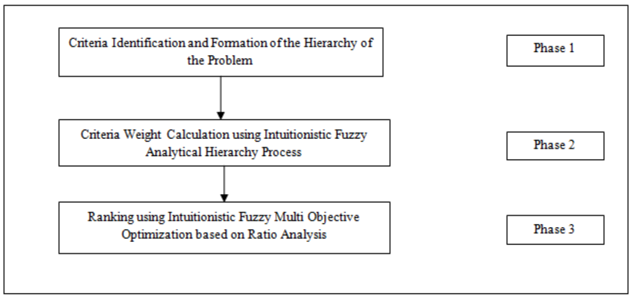

Figure 1: The Proposed Model

IV. Numerical Illustration

This study is conducted with the objective to rank OTA websites on the basis of success criteria. The numerical is modeled into three phases, as discussed in the previous section. The phases are performed as follows:

Phase 1: Construction of Hierarchy

In this phase, we convert our problem into a hierarchical structure. The goal of the problem is to find the best OTA website, which takes the highest level of the hierarchy. The success criteria or the factors form the middle level of the hierarchy and are stated as: Electronic word-of-mouth (J1), Service Quality (J2), Customization (J3), Content Quality (J4), Trust (J5), and Support (J6). The alternatives namely: H1, H2, H3, and H4 form the lowest level of the hierarchy. The structure is represented by Figure 2.

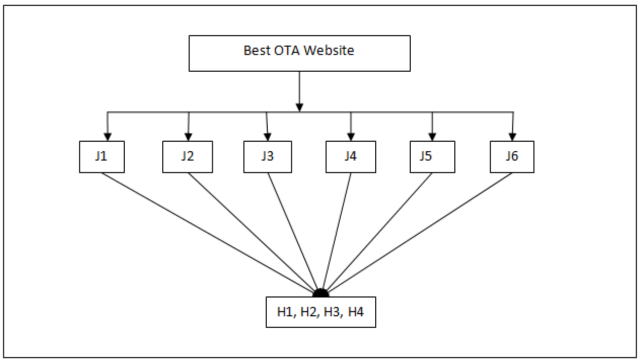

Figure 2: Hierarchy of the Problem

Phase 2: Criteria Weight Calculation using IFAHP

The set of alternatives is,

$$H = \{H1, H2, H3, H4\}$$

The set of criteria is,

$$J=\{J1, J2, J3, J4, J5, J6\}$$

Two decision makers are considered where the former is evaluated as an 'expert' and latter is evaluated as 'proficient'. The set of decision maker is,
$D=\{D1, D2\}$

The pair-wise comparison matrices for criteria as given by $D1$ and $D2$ are given in Table 3.

Table 3: Pair-wise Comparison Matrix for Criteria

Criteria Weights		J1	J2	J3	J4	J5	J6
J1	D1	EI	EI	MI	EI	MI	MI
	D2	EI	EI	MI	SI	SI	MI
J2	D1	EI	EI	MI	MI	MI	MI
	D2	EI	EI	MI	MI	MI	MI
J3	D1	VSNI	VSNI	EI	MI	MI	VSI
	D2	VSNI	VSNI	EI	MI	MI	MI
J4	D1	SNI	VSNI	VSNI	EI	EI	MI
	D2	SNI	VSNI	VSNI	EI	EI	MI
J5	D1	MNI	VSNI	MNI	EI	EI	MI
	D2	SNI	VSNI	MNI	EI	EI	MI
J6	D1	VSNI	VSNI	VSNI	VSNI	VSNI	EI
	D2	VSNI	VSNI	MNI	VSNI	VSNI	EI

The perfect multiplicative consistent intuitionistic preference relation matrix is obtained for each decision maker with inputs obtained using equations (5) and (6). Using the distance formula provided by equation (8), we found that $d\left(I_2^1, \acute{I}_2^1\right)<0.1$ and $d\left(I_2^2, \acute{I}_2^2\right)<0.1$. This proves that the preference relation matrices are consistent.

The performance value matrices of alternatives formed from the kth decision maker for first criterion are represented by Table 4.

Table 4: Pair-wise Comparison Matrix for Alternatives over Criteria

	FOR J1	H1	H2	H3	H4
H1	D1	EI	EI	MI	MI
	D2	EI	MI	MI	MI
H2	D1	EI	EI	MI	MI
	D2	VSNI	EI	MI	MI
H3	D1	MNI	VSNI	EI	MI
	D2	VSNI	VSNI	EI	EI
H4	D1	MNI	VSNI	VSNI	EI
	D2	MNI	VSNI	EI	EI
	FOR J2	**H1**	**H2**	**H3**	**H4**
H1	D1	EI	EI	MI	MI
	D2	EI	MI	MI	MI
H2	D1	EI	EI	EI	MI
	D2	VSNI	EI	MI	MI
H3	D1	VSNI	EI	EI	EI
	D2	VSNI	VSNI	EI	MI
H4	D1	VSNI	VSNI	EI	EI
	D2	MNI	VSNI	VSNI	EI
	FOR J3	**H1**	**H2**	**H3**	**H4**
H1	D1	EI	MI	MI	MI
	D2	EI	EI	MI	MI
H2	D1	VSNI	EI	MI	MI
	D2	EI	EI	MI	MI
H3	D1	VSNI	VSNI	EI	MI
	D2	MNI	VSNI	EI	MI
H4	D1	MNI	VSNI	EI	EI
	D2	MNI	VSNI	VSNI	EI
	FOR J4	**H1**	**H2**	**H3**	**H4**
H1	D1	EI	MI	MI	MI
	D2	EI	EI	MI	MI
H2	D1	VSNI	EI	MI	MI
	D2	EI	EI	EI	MI
H3	D1	VSNI	VSNI	EI	MI
	D2	VSNI	EI	EI	EI
H4	D1	MNI	VSNI	VSNI	EI
	D2	VSNI	VSNI	EI	EI
	FOR J5	**H1**	**H2**	**H3**	**H4**
H1	D1	EI	EI	MI	MI
	D2	EI	MI	MI	MI
H2	D1	EI	EI	MI	MI
	D2	VSNI	EI	MI	MI
H3	D1	MNI	VSNI	EI	MI
	D2	VSNI	VSNI	EI	MI

H4	**D1**	MNI	VSNI	VSNI	EI
	D2	MNI	VSNI	VSNI	EI
	FOR J6	**H1**	**H2**	**H3**	**H4**
H1	**D1**	EI	EI	MI	MI
	D2	EI	MI	MI	MI
H2	**D1**	EI	EI	EI	MI
	D2	VSNI	EI	MI	MI
H3	**D1**	VSNI	EI	EI	EI
	D2	VSNI	VSNI	EI	EI
H4	**D1**	VSNI	VSNI	EI	EI
	D2	MNI	VSNI	EI	EI

Using the distance formula provided by equation (8), we found that $d\left(I_{1j}^{g}, \acute{I}_{1j}^{g}\right) < 0.1\ \forall j=1,\ldots,6; g=1,2$. Thus, all the matrices are consistent. Also, we have considered that

$D1 = \{0.7, 0.2, 0.1\}$

$D2 = \{0.5, 0.4, 0.1\}$

Then, their corresponding weights are computed using equation (9) and $\lambda_1 = 0.58$ and $\lambda_2 = 0.42$.

Next we compute the aggregated intuitionistic fuzzy decision matrix using equation (10). Each value obtained is divided by summation of each criterion, and we obtain the normalized decision matrix. The criteria weights are obtained using the IFA operator given by equation (11). The weights are represented by Table 5.

Table 5: Criteria Weight Vector W_2

Criteria	Weight
J1	(0.58,0.16,0.26)
J2	(0.55,0.20,0.25)
J3	(0.46,0.35,0.19)
J4	(0.22,0.64,0.14)
J5	(0.25,0.60,0.15)
J6	(0.14,0.72,0.14)

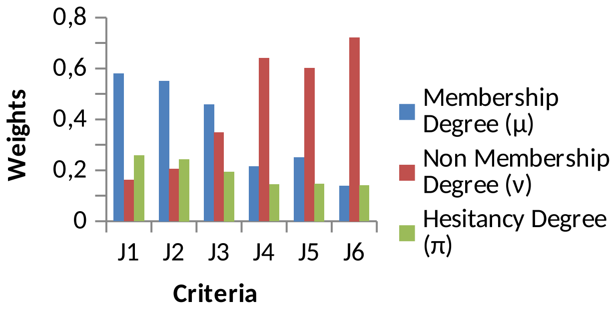

Figure 3: Criteria Weight Result

Phase 3: Rank Websites using IFMOORA

Combining the weights obtained using the decision matrices provided by $I_{1j}^{g}\ \forall j=1,\ldots,6; g=1,2$, we compute the decision matrix evaluating each alternative on each criterion. The matrix is represented by Table 6,

Table 6: Decision Matrix

	J1	J2	J3	J4	J5	J6
H1	(0.53, 0.32, 0.15)	(0.51, 0.32, 0.17)	(0.54, 0.30, 0.16)	(0.53, 0.29, 0.18)	(0.54, 0.30, 0.16)	(0.50, 0.34, 0.16)
H2	(0.48, 0.39, 0.13)	(0.44, 0.48, 0.08)	(0.46, 0.40, 0.14)	(0.44, 0.45, 0.11)	(0.48, 0.37, 0.15)	(0.43, 0.51, 0.06)
H3	(0.32, 0.54, 0.14)	(0.40, 0.54, 0.06)	(0.31, 0.57, 0.12)	(0.38, 0.53, 0.09)	(0.34, 0.49, 0.17)	(0.25, 0.71, 0.04)
H4	(0.22, 0.66, 0.12)	(0.27, 0.63, 0.10)	(0.24, 0.65, 0.11)	(0.24, 0.65, 0.11)	(0.16, 0.68, 0.16)	(0.19, 0.73, 0.08)

Multiplying the value of Table 5 and 6, we obtain aggregated weighted intuitionistic fuzzy decision matrix.

Next, we obtain the sum of benefits and costs criteria. The electronic word-of-mouth (J1) represents how efficient the website is in providing the customers a space to give feedback and interact with others. It consists of attributes such as: online reviews and star ratings; and is considered as a benefit criterion [7]. Service quality (J2) consists of attributes: responsiveness, reliability, assurance, and empathy; that convey the level of service provided by the website, which is to be maximized. Customization (J3) represents the potential of the website to provide personalized goods and service, consisting of attributes: up-selling, cross-selling. Previous researches have shown that much of customization is not beneficial from customers' perspective, since enough of complementary options may hamper their purchasing decision [10]; so is considered a cost criterion. The content quality (J4) consists of attributes such as: up-to-datedness, preciseness, timeliness, accuracy, and is considered to be beneficial criterion. The attributes security and privacy make up the criterion trust (J5), and is considered to be a beneficial criterion. Support (J6) consists of payment alternatives, frequently asked questions, account maintenance, and payment alternatives; and is considered to be a benefit criterion [12]. The sum of benefit and cost criteria is obtained.

Defuzzifying the sum of benefit and cost criteria using equations (15) and (16). Also, calculation of contribution of each alternative using equation (17) gives the final ranking. The results of the ranking are provided by Table 7,

Table 7: Ranking Result

Alternatives	$Defuz_i(Ben)$	$Defuz_i(\cos)$	$Contrib_i$	Rank
H1	1.23	0.58	0.65	4
H2	1.16	0.48	0.68	2
H3	1.05	0.33	0.72	1
H4	0.92	0.26	0.66	3

As seen from Table 7, ‘H3’ is the best alternative since it has the highest $Contrib_i$ value.

V. Conclusion

The intuitionistic fuzzy set concept was introduced to represent the hesitation or vagueness experienced by decision makers in decision making. Also, the previous studies based on various MCDM techniques using inputs from a single decision maker were found to be biased. Thus, recent studies have extended to group decision making (GDM). In this paper, we propose an MCGDM model that combines the technique of intuitionistic fuzzy Analytic Hierarchy Process (IFAHP) and Intuitionistic fuzzy multi objective optimization based on ratio analysis (IFMOORA). A numerical illustration based on ranking of OTA websites on the basis of success factors is performed. The IFAHP is used to obtain the success criteria weights and the IFMOORA technique is used to obtain the final ranking of the OTA websites. The model is found to be flexible and can be applied to various real life problems in future. For the future studies, various MCDM approaches can be combined in intuitionistic environment to perform evaluation and ranking problems in various fields.

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